Materials & Methods

Selection & use of

metals, nonmetallics, parts, finishes

in product design & manufacture

March 1956

Pressure Sensitive Tapes—M & M Manual No. 125

Ultra High Strength Steels

Teflon and Nylon Bearing Materials

New Aluminized Coating

Thorium-Magnesium Sheet for High Temperatures

Modified Woods—Old and New

Forgings Save Weight, Improve Design

Complete Contents—page 1

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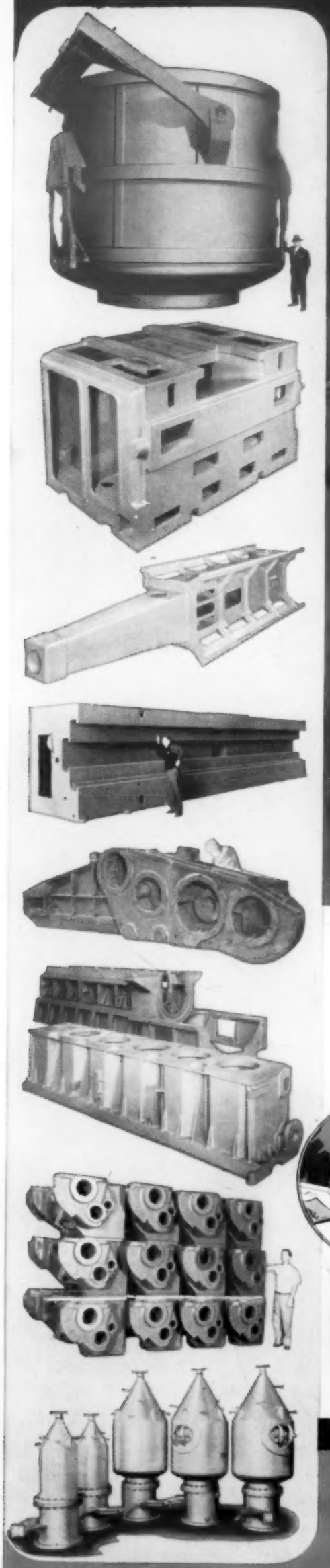

Steel-Weld FABRICATION

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Above you see one of four identical pieces recently produced and machined by Mahon. It is part of a machine designed for use in the manufacture of paper plates. This piece, and the parts and assemblies illustrated at the left, are typical of thousands of Steel-Weld Fabricated units produced and machined by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. Are YOU making full use of welded steel components in your products? In some instances pattern cost and time are an important factor . . . in others the strength-weight ratio is important. In the design of almost any type of heavy machinery, there are pieces and sub-assemblies that lend themselves to more economical production in welded steel. If you build such machinery or equipment, you will be interested in Mahon's facilities to serve you . . . because, the Mahon organization is a unique source for welded steel in any form . . . a source with complete facilities for design engineering, fabricating, machining and assembling. See Sweet's Product Design File for information, or have a Mahon engineer call at your convenience.

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MARCH 1956 **VOL. 43, NO. 3**

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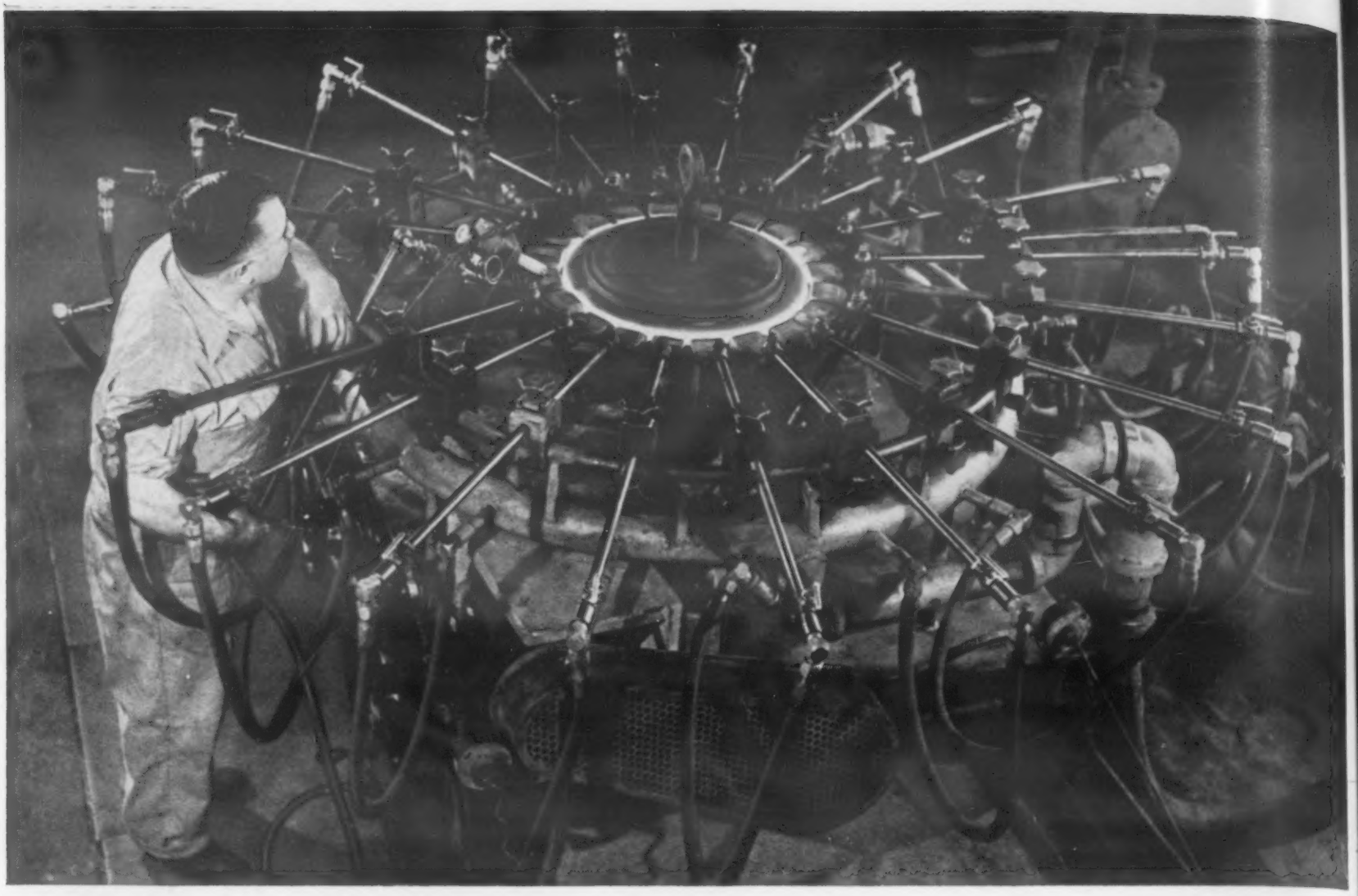
REENTERED AS SECOND CLASS MATTER JULY 19, 1951, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER THE ACT OF MARCH 3, 1879. ESTABLISHED IN 1929 AS METALS AND ALLOYS.



Flame hardening set-up shows an application of Selas "Superheat" burners at the Wiedermann Machine Co., Philadelphia. With burners grouped like this, high temperature effects are intense. In this service, Inconel jackets give 5 times the life of any other alloy tried.

Sheathed with Inconel

these "Superheat" Burners last 5 times longer

"Inconel shells mean big savings for our customers," Selas says

These "vest-pocket" Selas furnaces blast out heat at rates on the order of 2000 feet per second . . . 40,000,000 BTU/ft³. Jet action is so strong, work pieces are sometimes heated, formed, and delivered by thermal impact alone.

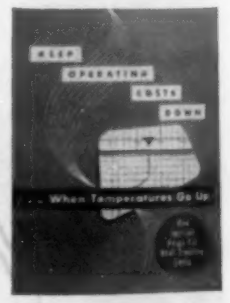
Metal burner shells used to burn out fast. In one severe application, jackets averaged only 100 hours. Now, Inconel sheathing gives a minimum of 500 hours.

"In this operation (surface hardening)," says Selas, "Inconel shells cut costs approximately 70%."

What's hot in your shop?

Whatever it may be, chances are, Inconel can handle it. Here are three reasons why:

1. **Inconel stays usefully strong up to 2100°F., resists thermal shock.**
2. **Inconel resists oxidation, hydrogen embrittlement, many other types of corrosion.**
3. **Inconel is easy to form, machine, weld . . . available in all commercial forms.**



A new Inco booklet, "Keep operating costs down, when temperatures go up" suggests many ways to use Inconel and other Inco heat resisting alloys effectively. Dozens of types of equipment shown. Write for a copy.

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Materials Outlook

DIRECT PLATING OF CHROMIUM ON ALUMINUM is a commercial reality. One process will be used in a new plant just set up in England. The process being used in this country is claimed to produce a ductile coating having excellent wear resistance; average hardness is Rc 72. (More details in a forthcoming issue.)

POLYMERIZATION OF ETHYLENE BY RADIATION is a prospect that continues to interest scientists. The technique would presumably eliminate many of the complexities of present commercial processes, both high-pressure and low-pressure. Latest experiments show that as little as 100,000 curies of radioactive cesium would suffice to make 1000 tons of polyethylene. A major incentive behind such investigations is the desire to find uses for rapidly accumulating radioactive waste.

HIGH PURITY COBALT, 99.99% free of contamination by other metals, has been produced through electrolysis. Although it is still in the laboratory stage, several pounds of the nearly pure cobalt can be produced at a time.

A ZINC-FREE ALLOY OF COPPER, NICKEL AND ALUMINUM combines light weight and high strength with excellent resistance to corrosion. Tests show a corrosion fatigue limit in salt water of 20,000 psi for the new alloy, contrasted with 12,000 psi for manganese bronze.

USE OF POLYETHYLENE IN STORAGE BATTERIES increases service life by 20% and makes possible an increase in capacity. The plastic is used for tubing and tube sealers which encase the active material, and for the grid spines of the positive plates. Big advantage of polyethylene is that it can be slotted to a greater percent porosity than rubber with less loss of the active material.

THE 1500th AMERICAN STANDARD was recently approved. The standard was submitted by ASTM for nickel-chromium-iron seamless pipe and tube specifications.

STIFFER, STRONGER GLASS-REINFORCED LAMINATES can be made with the "high-modulus" glass fabrics now coming into use, it is claimed. These fabrics utilize very light yarns in the full direction — so light that they do not crimp the load-carrying yarns in the warp direction. As a result there is no sinuosity that must be stretched out before the cloth reinforcement assumes its full share of the

Materials Outlook

load on the laminate. In addition to greater stiffness and strength, these fabrics are said to provide maximum control over strand orientation in contour molding, and to eliminate shearing effects at strand cross-over points.

A BLEND OF EPOXY AND POLYAMIDE RESINS offers definite advantages for plastics tooling. The blend preserves most of the favorable properties of epoxies and eliminates the toxic amine-type curing agents. (More details in a forthcoming issue.)

DIFFUSION BONDING OF STEELS for high strength applications reportedly results in a joint equal to the strength of the original steel. The bonding method is essentially a brazing process in which the filler metal diffuses into the parent metal. Bars of 4340 have been butt-jointed and heat treated to a tensile strength of 182,000 psi.

DIFFICULT MATERIALS CAN BE SOLDERED with common lead-tin solder and flux by at least two new methods. One technique utilizes a grinding wheel and permits the joining of glass, aluminum, stainless steel and other materials usually considered unsolderable. Details of the other method have not been revealed, but it has demonstrated that aluminum can be soldered as easily as brass and will probably be used to solder aluminum cans.

STRENGTHS OF ADHESIVE BONDED METAL JOINTS can be made to approach the cohesive strength of the bonding agent if the metal surfaces are treated properly. With one organic adhesive, loads required to break the adhesive bond between two similar metals have exceeded 7000 psi for stainless steel, 5500 psi for aluminum, 7000 psi for titanium and 4000 psi for magnesium.

RECENT WORK ON TIN ALLOY COATINGS indicates that substitution of a part of the nickel layer in nickel-chromium coatings by a layer of tin bronze holds promise of reducing pore corrosion.

A NEW TYPE OF POLYURETHANE FLEXIBLE FOAM now under development closely resembles foam rubber in its compression-deflection characteristics. Presently available urethane foams, made primarily by reacting a diisocyanate with a long-chain ester, have resiliency much different from that of foam rubber; the material has high resistance to deformation up to about 20% deflection, then deforms readily through most of its useful range. The new type utilizes an ether instead of an ester. Because of its more conventional resiliency characteristics, similar to those of foam rubber, it may be preferred to the ester type for certain applications, e.g., seating.

Materials BRIEFS

Tinless Can
Food cans lined on the inside with special enamel may mark the end of an era. Outside of can is coated with aluminum to provide an attractive finish.

Aluminum Bows to Plastics
Translucent plastics panels will be used as sidelights in a new aluminum plant. Light in weight, the entire shipment of over 60,000 sq ft of panels were loaded on a single flat-bed truck.

Scrap Available
Interested firms can obtain uranium-bearing flouride scrap generated as a by-product in plants producing feed materials for use as reactor fuels. From 4000 to 8000 tons of scrap material will be available annually.

Pristine Bourbon
Drinks of all kinds can be cooled without dilution. Liquid sealed in a plastic bag is frozen before being submerged in the beverage. Added feature is a stem for stirring.

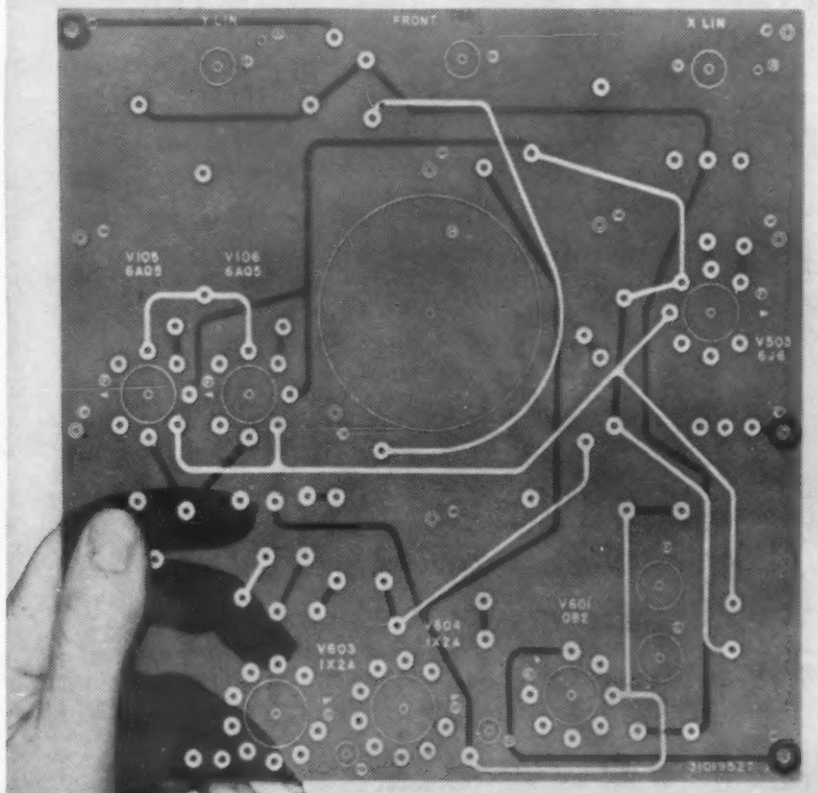
Two Billion Testers
New cars on the New York subway lines have stainless steel seat risers, wainscoting, heater grilles, and stanchions. Metals must withstand the kicks and scuffs of the estimated two billion riders transported yearly.

Pent-up Plastics
Techniques have been developed for measuring residual stresses in molded plastics. Aim is to produce plastics with low or non-existent stresses.

Pursuit of Knowledge
Industrial research expenditures in 1956 will exceed $5 billion. Industry now recognizes research as a separate activity which can be looked upon somewhat like a capital investment.

Below . . . No problem with electrical properties when your printed circuits are based on XXXP laminates made with RCI PLYOPHENS 5027 and 5036.

Photos courtesy of The Formica Company



Above . . . You cut treating machine time when filler sheets for high pressure decorative laminates are made with RCI PLYOPHEN 5573.

Left . . . You reduce stock losses when you use PLYOPHEN 328 for binding fibrous glass or mineral wool into insulation batts. And P-328's low alkalinity definitely improves the water resistance of the insulation.

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Men of Materials...

Frank L. Whitney, Jr. is Manager of the Corrosion Section, Engineering Dept., Research and Engineering Div., Monsanto Chemical Co. Currently serving as President of the National Association of Corrosion Engineers, Mr. Whitney is also a member of the American Standards Association, ASM, ASME and ASTM. A registered professional engineer, he teaches a course in Corrosion Technology at Washington University.

Whitney says:

"Few engineers fully understand the corrosive forces with which they must contend."

"Each year, corrosion costs American industry an estimated six billion dollars. The proper knowledge of materials easily can save many of those capital and maintenance dollars.

"That's the job of the corrosion engineer; safeguarding plant investment and engineering adequate maintenance at minimum cost. In the chemical process industries, far and away the leaders in capital investment growth, his job is an ever-growing responsibility. Combatting chemical and chemical-mechanical corrosion mechanisms with remedial measures is not enough. Prevention is the keynote—'stopping corrosion before it starts'.

"Industry still hasn't answered its six billion dollar corrosion question successfuly. I do not beieve that it can fully answer that question until there is a more fundamental and widespread knowledge in industry of the mechanisms by which corrosive environments destroy construction materials.

"Let's face it: most of the men in the field of corrosion engineering today (and I include myself) gained their specialized knowledge of this field through the trial and error of long industrial experience. However, this vast fund of empirical data has been gathered at a considerable industrial cost.

"Perhaps it is time that young men be offered formal training as corrosion engineers. Short corrosion courses are offered through the NACE, in cooperation with a number of universities to assist industry in training men for this field. These courses are no real substitute, however, for a full and formal curriculum.

"I would like to see industry, the technical societies and the universities make a combined effort to activate such a curriculum. It surely would be more profitable to industry to train young engineers at the college level, reaping the benefits at an earlier stage of their industrial service, than to depend upon their later trial and error training in industry."

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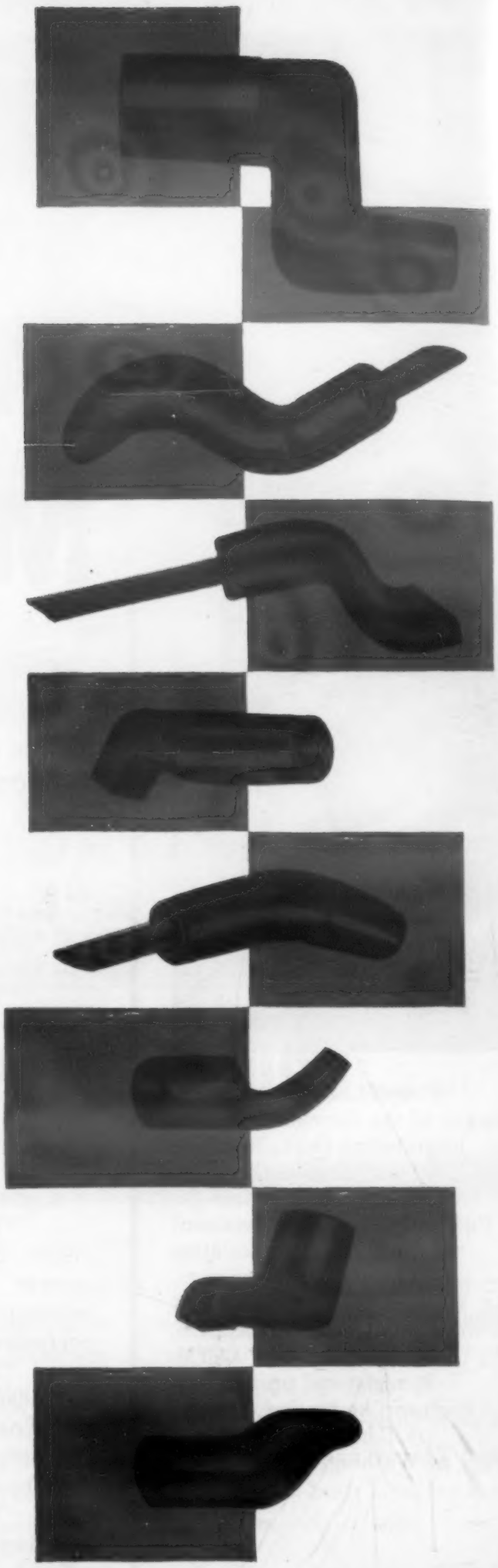
Stock Mallory straight electrodes, holders, seam welding wheels, dies, forgings and castings are listed in the latest edition of our Resistance Welding Catalog. Write today for this valuable reference book . . . and see your local Mallory welding distributor for prompt delivery of high quality welding supplies.

*Patent No. 2,489,993.



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MATERIALS ENGINEERING NEWS

X-ray System

Aluminum vs Steel

German Plastics Use

Automotive Styling

American Standard

TV x-ray system. *General Electric's new TV-intensified x-ray system reveals and magnifies internal structure of a steel-clad aircraft component.*

GE Inspection System Produces Bright X-ray Image

Elaborate operator protection devices coupled with low fluoroscopic screen light levels tend to rule out x-ray inspection in many product fields. Seeking to eliminate these handicaps, J. E. Jacobs and Harold Berger of General Electric have developed a new system of x-ray inspection which produces an image 10,000 times brighter than a fluoroscope screen with little or no danger to the operator.

Heart of the GE system is a new x-ray camera tube which "holds" the x-ray image for conversion into an electrical signal. The system works this way: The x-ray beam passes through the specimen and strikes a photoconductive layer of lead oxide painted on the inside of a special 8½-in.-dia TV pickup tube. Next, a low speed electron beam reads the latent image on the lead oxide layer by scanning it and presents the image, electronically amplified, on a TV tube similar to that used in a conventional receiver.

Great versatility

Because the image is strengthened electrically, x-ray source intensity can be greatly reduced, thus cutting down on the amount of protective shielding needed without increasing the hazard to inspecting personnel. In addition: the signal can be transmitted to other receivers at any distance from the inspection area; it can be recorded on magnetic tape for a permanent record; or the image can be photographed from the viewing screen. The system responds to x-rays generated at voltages as high as 1 million—powerful enough to penetrate 2 in. of steel.

Maximum area which can be scanned is 8 in. in diameter with a contrast sensitivity of 6 to 8%, roughly comparable to that of a conventional fluoroscope. Weight of the system is less than 150 lb, and the voltage required to scan the x-ray image on the TV camera tube is only 250 v, less than that used in most TV home receivers.

Industrial use

In a field evaluation of the new system, a plant was chosen which depended upon fluoroscopic inspec-

(Continued on p. 236)

German Per Capita Plastics Use Two to One Over U. S.

While the U. S. tops Germany in actual tonnage of plastics produced, the German industry's rate of growth leads ours with a two-to-one edge in per capita plastics use. So observed J. A. Neumann, president and director of research of the American Agile Corp., upon his return from the recent plastics show at Dusseldorf.

HOW NATIONS COMPARE IN PLASTICS PRODUCTION
(in thousands of tons)

	1938	1943	1947	1951	1952	1953	1954
United States	59	297	611	1160	1103	1318	1335
Germany	60	250	228	191	195	250	338
Great Britain	30	50	108	160	150	185	250
France	12	13	24	40	35	46	78

A great part of this accelerated growth is due to Germany's lack of domestic metal supplies. The U. S. is holding to stainless steels and monel which are more abundant in this country than abroad. The Germans, however, are replacing stainless steel with high tensile polyethylene.

Polyvinyl chloride continues to be the workhorse of the plastics field in Germany, particularly in the realm of structural materials. But it is expected to give way to polyethylene H-T as soon as that material becomes more readily available. As tensile strength is increased along with the ability to withstand heat, polyethylene will continue to come into greater demand. But from the view of present cost and production, most consumers still look to PVC. Where great tensile strength is required, the Germans use steel that has been flame or spray coated with polyethylene H-T.

According to Dr. Neumann, one of the most progressive steps in materials improvement was the development of a polyethylene with a tensile of 8000 psi. Most polyethylene now being produced has a tensile strength of 5000 psi. The additional tensile strength will make polyethylene H-T an even better structural material for industry and open up other possibilities for use. One German manufacturer is using the polyethylene H-T for water mains and other types of conduits.

H-T in the lower tensile range is available in good quantities in Germany. The American-made H-T, both that produced by the Ziegler licensees and those using the Phillips Petroleum Co.'s Marlex process, is primarily in the pilot plant stage (M&M, July 1955, pp. 88-91).

World Survey Points Up Competition Between Aluminum and Steel

Healthy competition between aluminum and steel keeps design and materials engineers on their toes with benefits to both user and consumer. This is the opinion of Paul Brenner writing in a recent issue of *Stahl und Eisen.* After reviewing the past and present situations, Brenner concludes that the uses of aluminum will continue to multiply, in part at the expense of steel.

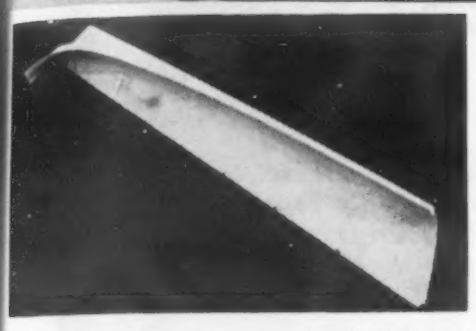
Although the strength characteristics of steel on a volume basis are greater than those of aluminum, this does not hold true when specific weight is taken into consideration. Aluminum also loses strength more rapidly at moderately elevated temperatures, but aluminum alloys are used for various parts operating at these tem-

(Continued on p. 238)

Industry	Aluminum Not in Competition with Steel, % Use As: Sheet	Profiles, Tubes, etc.	Castings, Forgings	Other	Aluminum in Competition with Steel, % Use As: Sheet	Profiles, Tubes, etc.	Castings, Forgings	Other	Total Aluminum, Use in %
Electric	1	11	—	—	—	—	—	—	12
Aircraft	5	1	1	—	—	—	—	—	7
Chemical	—	—	—	3	—	—	—	—	3
Construction	3	1	1	—	8	8	—	—	21
Machinery	—	—	3	—	2	3	2	—	10
Household Equipment	—	1	2	—	9	1	1	—	14
Vehicles	—	—	2	—	5	1	5	—	13
Containers	5	—	—	—	2	—	—	—	7
Ship and Railroad	—	—	1	—	2	—	—	—	3
Other	—	—	—	—	—	—	—	10	10
Total	14	14	10	3	28	13	8	10	100
Estimated Aluminum Consumption, 1000 tons*	350	350	250	80	700	320	200	250	2500
Amount of Steel Replaced, 1000 tons*	—	—	—	—	2000	900	600	—	3500

* *for 1952.*

Plastics styling. *Rear fender fins of reinforced plastics are shown installed on a Studebaker station wagon. Left fin is unpainted.*



Plastics fins *are molded in one piece and painted before being put on cars.*

Reinforced Plastics Cut Cost in Automotive Styling

Production steps from clay design to finished car are time consuming and costly operations. No one is more aware of this than the automotive styling engineer who is often frustrated by the difficulty of stamping metal into certain shapes and contours.

On the other hand, the reinforced plastics industry boasts that its product lifts the horizon of styling by offering design flexibility and low weight to strength ratio. Cost and time, the plastics men point out, are saved by the relatively low die cost compared with that of metal forming dies and by the simplicity of molding one piece, compound-curved structures.

Last year Studebaker technicians took a look at the proposed rear end of their station wagon and Golden Hawk series. They decided that the contours of the rear fender fins offered an excellent opportunity to try reinforced plastics on a major scale. This year's models show the result. The plastics part styles the rear end of the cars with about an 80% saving in cost over metal fabrication.

In addition to the rear fin, glass reinforced plastic is used on the instrument panels of the Hawk sports-type cars, and a metallized Mylar panel is used to enhance the interior decor on the door panel of the President series and Hawks.

On the production line, each metal and plastics part is painted when formed and baked dry in an infra-red oven. Metal parts are baked 17 to 20 min at temperatures near 250 F while the plastics parts are dried at 180 F in approximately the same time. Temperatures higher than 180 F cause the plastics to warp.

Studebaker engineers are watching the performance of these plastics parts with an eye to expanded use. If reinforced plastics are successful in the popular cars, their ease of fabrication may well cause a revolution in automotive styling.

(More News on p. 241)

DESIGN ENGINEERING SHOW

"Tomorrow's Products Are Tomorrow's Markets" has been set as the theme for the First Design Engineering Show at Convention Hall, Philadelphia, May 14 to 17.

Over 200 companies are expected to display their products, ranging from materials, components, and finishes to special services available to engineers and designers.

Conferences to run concurrently with the show are being sponsored by the Machine Design Div. of ASME. They include discussions on cost reduction in product design, finding and training men for the design engineering field, selection of engineering materials, effect of miniaturization upon design, compensating employees for inventions, and rights of a company employee in inventions he develops.

H. R. Clauser, editor of MATERIALS & METHODS, is one of the four participating editors drafting the conference program for the four day meeting.

LETTERS TO THE EDITOR

Dip processes

To the Editor:

In the article, *Finishes for Metal Products* MATERIALS & METHODS of Sept. 1955, page 119, you state that standard and proprietary dip processes are available for blackening copper and brass.

This shipyard is interested in a coating that will blacken small brass castings and increase the resistance to saltwater corrosion.

Your help in giving us more detailed information, or referring us to a source where we could obtain this information will be greatly appreciated.

J. S. FLETCHER
New York Naval Shipyard
Brooklyn 1, N.Y.

We have no knowledge on resistance of the standard or proprietary black dip coatings to salt water corrosion. Possible sources of information have been sent.

Correction

To the Editor:

With reference to the article on *Finishes for Metal Products* in your Journal of September 1955, p. 117 and onwards, I was particularly interested in the reference to lead tin coatings on strip referred to towards the bottom of p. 128 of that issue. It indicated that terne coated strip was commercially available.

I should be grateful to have from you any further information you can provide or references to the literature on plants and processes for the preparation of terne coated continuous strip. I realize that terne coated sheet, as produced by orthodox hot dipping, has been available for many years.

S. S. CARLISLE
Head of Laboratories
The British Iron & Steel Research Association
Swansea, South Wales

Inclusion of the word "strip" was an error. To the best of our knowledge, terne coated strip is not commercially available.

Inorganic papers

To the Editor:

In your December, 1955, issue there is an article entitled, "Four Inorganic Papers." The author is Thomas D. Callinan, U. S. Naval Research Laboratory, and he covers a very broad subject in a concise and interesting manner. However, we feel there are some errors and implications which possibly should be corrected.

First, there is the table at the start of the article. For tensile strength it gives the value of 45 psi for asbestos. If the author is referring to pure asbestos Quinterra sheet made by Johns-Manville this value should be 150 psi.

Then, there is an error on the third page of the article. This page is made up of two pictures with a caption between. The upper picture shows tapes of Quinterra being machine wrapped on to wire. The

(Continued on p. 268)

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PLEASE NOTE: Because of the large quantity of literature reviews this month, some numbers on reply card normally reserved for advertisements are being used to identify Manufacturers' Literature items.

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21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170
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Information on Advertisement No.

301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
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TRADE SHOWS

DESIGN ENGINEERING SHOW. Clapp & Poliak, Inc. Literature, for both visitors and exhibitors, describing the Design Engineering Show—to be held in Philadelphia, May 14 to 17—as well as free admission tickets for visitors. (1)

METAL POWDER SHOW. Metal Powder Association. Literature for both visitors and exhibitors describing the Metal Powder Show—to be held in Cleveland, April 10 to 12. Free admission tickets. (2)

PLASTICS SHOW & CONFERENCE. Society of the Plastics Industry, Inc. Literature describing National Plastics Exposition and concurrent Plastics Industry Conference—to be held in New York City, June 11 to 15. (3)

MANUFACTURERS' LITERATURE

New Literature

Die Steel. Allegheny Ludlum Steel Corp. Data sheet on Ontario-EZ free machining air hardening die steel. (4)

Honeycomb Materials. Anocut Engineering Co., 6 pp, illus, No. 156. Photographs and data on the electrolytic process of shaping honeycomb materials. (5)

Iron Powders. Antara Chemicals Div., General Aniline & Film Corp., 31 pp, illus. Illustrated booklet giving properties of Carbonyl Iron powders. Tables and charts. (6)

Sintered Bronze. Bunting Brass & Bronze Co., 12 pp., illus, P 56. Information on stock bearings, flange stock bearings, washers and bars made of sintered bronze. (7)

Rubberized Abrasives. Cratex Mfg. Co., 2 pp, illus. Performance of rubberized abrasives in burring, smoothing and polishing metals, plastics, ceramics and glass. (8)

Specialty Steels. Crucible Steel Co. of America, 32 pp, illus, No. TM9. Information on cold rolled specialty steels, including stainless, alloy and carbon spring steels. Also hardness conversion numbers, decimal equivalents and weight-size tables. (9)

Vinyl Lacquers. Davison Chemical Co., Div. of W. R. Grace & Co., 5 pp. Technical bulletin on use of Syloid 244 for flatting vinyl lacquers to give a low-gloss effect (10)

Titanium. E. I. duPont de Nemours & Co., Inc., 8 pp, illus. Up-to-date data on properties of titanium and methods of fabricating the metal. (11)

Vinyl Foam. Elastomer Chemical Corp., 14 pp, illus. Details on vinyl foam used in industry, with advantages and applications. (12)

Silicone Rubber Parts. Plastic Dept., General Electric Co., 4 pp, illus. Fabrication of silicone rubber parts for industry. Includes basic properties chart. (13)

Metal Powders. The Glidden Co., 6 pp. Contains specification sheet for lead and Resistox copper powders. (18)

Polyester Resins. Finishes Div., Interchemical Corp., 224 McWhorter St., Newark, N. J. Series of bulletins covering resin and other polyester products used in hand lay-up applications. Write direct to Interchemical on company letterhead.

Fluorocarbon Plastics. Chemical Mfg. Div., M. W. Kellogg Co., 15 pp. Buyers' guide for molded and fabricated materials and products made of trifluorochloroethylene polymer. Also information on technical services offered. (157)

Glass Fibers. L. O. F. Glass Fibers Co., 4 pp, illus, No. WAF-1. Gives performance and conductivity charts for insulating blankets, and describes properties and uses in acoustical and (200)

Iron Powders. Plastics Metals Div., National-U.S. Radiator Corp., 12 pp, illus,

PLEASE NOTE: Because of the large quantity of literature reviews this month, some numbers on reply card normally reserved for advertisements are being used to identify Manufacturers' Literature items.

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29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
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No. 2. Describes and illustrates the manufacture of electrolytic and reduced iron powders (14)

Ceramic Materials. Stupakoff Div., Carborundum Co., 6 pp. Physical and electrical characteristics of ceramic materials. Also features design considerations for engineers. (15)

Cutting Machine. Air Reduction Co., 20 pp, illus, No. 804A. Operating and construction features of oxyacetylene multiple-torch, shape cutting machine. (16)

Plastics News. American Agile Corp. Bi-monthly external house organ giving news of the company activities in the plastics field. (17)

Soldering Applications. Anchor Metals Co., Inc. Guide to industrial uses of solders and fluxes. Special section includes problems in aluminum soldering and their solutions. (19)

Steel Tubing. Babcock & Wilcox Co., 8 pp, illus, No. TB-408. Lists types of tubing available, and tabulates properties of 20 steels ranging from carbon to stainless. (20)

Testing Machine. Baldwin-Lima-Hamilton Corp., 12 pp, illus, No. 4401. Hydraulic machines with capacities from 10,000 to 5,000,000 lb are described, including standard and special types of vertical and horizontal machines. (21)

Nylon Molding Compounds. Barrett Div., Allied Chemical & Dye Corp., 4 pp, illus. Molding characteristics and physical properties of Plaskon molding compounds and Plaskon polyethylene lubricants. (22)

Corrosion and Contamination. Bass & Co., Inc., 8 pp, illus. Discusses corrosion and contamination problems, and uses of electro-clad nickel-lined pipe. (23)

Carbide Tools. Besly-Metro Div., Besly-Welles Corp., 12 pp, illus, No. 850C. Contains charts and descriptions of various types, sizes and styles of standard and special carbide tools. (24)

Presses. E. W. Bliss Co., 32 pp, illus, No. 11B. Six basic types of presses, from 200 to 2500 tons, are described. Presses are designed to meet requirements of automated production lines. (25)

Steel Tubing. Tubing Div., Brainard Steel Co., 8 pp, illus. Welded mechanical and structural steel tubing, with tables on weight per linear foot, size tolerances and gauge tolerances. (26)

Corrosion Resistance Coatings. Carboline Co., 4 pp, No. 701. Describes Neoprene W, a single package synthetic rubber coating for use in corrosive atmospheres in general plant maintenance. (27)

Corrosion Resistance Coatings. Chromalloy Corp., 3 pp, illus. Copy of reprint entitled "Chromium Impregnation for Corrosion Resistance and Wear Protection." (28)

Metal Cleaning. Circo Equipment Co., 4 pp, illus, No. 521. Standard and special apparatus for handling practically every type of grease or dirt removal problem. (29)

Metallic Coatings. Coating Products. Attractive brochure describes the various coatings applied to plastics materials. Samples included. (30)

Pipe and Fittings. Colonial Plastics Mfg. Co. Series of bulletins describing pipes and fittings made of rigid unplasticized polyvinyl chloride. Includes data on valves. (31)

Forgings for Industry. Consolidated Industries, Inc., 20 pp, illus, No. F5954. Illustrates parts and describes advantages of forgings for a variety of applications. (32)

Felt Samples. Continental Felt Co., 4 pp, illus. Table of industrial felt specifications. Samples included. (33)

Bearing Bronze. Continuous-Cast Products Dept., American Smelting & Refining Co., 6 pp, illus, No. 301. Presents in tabular form all continuous cast stock sizes and weights for solid and hollow bronze bars ½ to 9 in. in dia. (34)

Plastic Pipe and Fittings. Corning Glass Works, No. PE-40. Physical properties. uses and specified dimensions of PVC pipe and fittings. (35)

Plastic Overlay. Crown Zellerbach Corp., 1 p. Specification sheet giving technical data on CreZon, a plastic overlay for plywood. (36)

Weldments. Cruse-Kemper Div., C. H. Wheeler Mfg. Co., 4 pp, illus. Describes weldments fabricated and machined to meet specific design, quality and cost requirements. (37)

Metal Finishing. Despatch Oven Co., 16 pp, illus, No. 51. Data on metal finishing systems, with suggestions on achieving better finishes and faster production. (38)

Protective Coatings. Diamond Alkali Co., 36 pp, illus. Data on chlorinated paraffin, both resinous and liquid grades, with illustrations of typical industrial applications. (39)

Insulation Fixtures for Welding. Diamonite Products Div., U. S. Ceramic Tile Co., 8 pp, illus. Custom insulation shapes for induction heating, welding and brazing. (40)

Silicone Reference Guide. Dow Corning Corp., 12 pp, illus. Describes 150 most generally used silicone products. Products grouped by physical form, cross-indexed by usage. (41)

Neoprene Notebook. Elastomers Div., E. I. du Pont de Nemours & Co., No. 67. Gives new information and case studies on use of neoprene. (42)

Plastics Extrusion and Injection Molding. Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc. Describes extrusion and injection molding of Alathon polyethylene resins. (43)

Nonmetallic Impellers. Eco Engineering Co., 2 pp, illus. Findings on physical and chemical characteristics of nonmetallic impellers for displacement pumps. (44)

Puerto Rican Plastics Industry. Economic Development Administration, Commonwealth of Puerto Rico, 3 pp. Includes in question-and-answer form facts about Puerto Rico for plastic manufacturers. Special emphasis on tax exemptions. (45)

Abrasives. Elgin National Watch Co., 4 pp, illus. Describes Dymo-C, a diamond abrasive for finishing carbide dies. (46)

Malleable Iron Castings. Elwell-Parker Electric Co., No. 31. Reports on the handling of malleable iron castings by a New England foundry. (47)

Precision Castings. Engineered Precision Casting Co., 5 pp, illus. Details tooling charge rebate plan and describes facilities of company. (48)

Silicone Rubber Products. Garlock Packing Co., 8 pp, illus, No. AD147. Applications and physical data on silicone rubber products. (49)

Rivets. Gibson Electric Co., 6 pp, illus, No. C-521. Describes rivets for use in electrical contacts. (50)

Keying and Pinning Devices. John Gillen Co., Inc., 4 pp, illus. Illustrates keys and pins available for assembling operations. (51)

Plastics for Textiles. B. F. Goodrich Chemical Co., 16 pp. Service bulletin on use of Hycar lattices in textiles. Includes chart showing physical properties of Hycar lattices in typical fields of application. (52)

Brass. Hampden Brass & Aluminum Co., 262 Liberty St., Springfield, Mass., 24 pp, illus. Describes manufacturing facilities of the company and of the Fibermold Div., makers of reinforced plastics. Write direct to Hampden on company letterhead.

Buffing and Polishing. Hanson-Van Winkle-Munning Co., 24 pp, illus, No. Co-103. Characteristics and uses of over 100 buffing and polishing compounds. (53)

Perforated Materials. Harrington & King Perforating Co., 8 pp, illus., No. 62. A handy thumb index catalog illustrating different standard patterns and giving information on hole size, centers and percent of open area. (54)

Heat Treating. A. F. Holden Co., 20 pp, illus. Data sheets on furnaces and techniques for austempering and martempering. (55)

Die Casting Lubricants. E. F. Houghton & Co., 4 pp, illus. Outlines development of die casting lubricants to meet modern high production needs. (56)

Rubber Rolls. Rodney Hunt Machine Co., 64 pp, illus, No. 8. Handbook on rubber rolls, including a standard selection table. (57)

Compression Spring. Hunter Spring Co., Flexator Div., 16 pp, illus, No. 313A-1-55. Characteristics and properties of compression spring, with tabular form design charts. (58)

Alloys for Heat Exchange Problems. International Nickel Co., Inc., 28 pp, illus. Presents typical installations of cupro-nickel or nickel-copper alloys in power plants. (59)

Centrifugal Castings. Janney Cylinder Co., 8 pp, illus. Company facilities for centrifugal casting of special alloys. (60)

Manufacturers' Literature

Metal Powder Parts. Johnson Bronze Co., 4 pp, illus. Illustrates self lubricating bearings, bushings and structural parts made of iron and bronze powdered metals. Includes table of alloys with composition and average physical properties. (61)

Wire Rope. Jones & Laughlin Steel Corp., Wire Rope Products Div., 60 pp, illus. Handbook entitled "Wire Lines for Drillers" covers wire rope application in oil, gas and water well drilling operations. (62)

Aluminum Mill Products. Kaiser Aluminum & Chemical Sales Corp., 24 pp, illus. Data on aluminum alloys, forms, mechanical and physical properties, applications, fabricating and finishing techniques, and availability. (63)

Wire. Keystone Steel & Wire Co., 12 pp, illus, No. 1a, Ke. Illustrates the various kinds of wire available and provides information about the cold heading operation. (64)

Rubber Design Handbook. Lavelle Rubber Co., 80 pp, illus, No. MT-56. Basic facts pertaining to the design of custom-made rubber and rubber-like articles are given in this thumb indexed handbook, together with actual samples of products. (65)

Rare Earths. Lindsay Chemical Co., 12 pp, illus. Describes company's work in the rare earth field. (66)

Wire Gage Chart. Little Falls Alloys, Inc. Chart for determining gage and footage readings in Brown & Sharp (A. W. G.) wire gages. Variety of other physical properties also shown. (67)

Silver Brazing. Lucas Milhaupt Engineering Co., 16 pp. Information on silver brazing, its advantages and its uses. Charts illustrate the types of joints and recommended preforms and give other specification data. (68)

Rubber Linings. Manhattan Rubber Div., Raybestos-Manhattan Inc., 12 pp, illus, No. 7115. Corrosion-, abrasion- and contamination-resistant rubber linings for tanks, pipe valves and similar storage and process equipment. (69)

Plastics Tooling. Marblette Corp. Series of bulletins outlining manufacture, uses and advantages of plastic draw dies, stretch press dies and hydroform dies. (70)

Metal Surface Treatment. Metasurf Corp., 4 pp, illus. Describes product, Metacote, which prevents paint failures on practically all metals and metal alloys. (71)

Castings. Midwest Foundry Co., 12 pp, illus. Case-history product development photographs. Describes investment castings and close-tolerance shell mold castings in gray iron, stainless and alloy steel. (72)

Adhesives and Coatings. Adhesives & Coatings Div., Minnesota Mining & Mfg. Co., 12 pp, illus. Properties and applications of a wide variety of adhesives, coatings and sealers. (73)

Urethane. Mobay Chemical Co., 16 pp, illus. Pictures applications of urethane and outlines its possibilities for use in synthetic rubber and adhesives. (74)

Rotary Embossing Machinery. Modern Engraving & Machine Co., 6 pp, illus. Discusses improved strength, appearance and sales appeal of embossed metal and shows typical embossed patterns and applications. (75)

Pipe and Fittings. A. B. Murray Co., Inc., 18 pp, illus, Vol. 9, No. 1. Specifications for all types of tubular products. Includes American Standards Association pipe schedules. (76)

Die Castings. National Die Casting Co., 8 pp, illus, No. 266. Describes die casting facilities of company. Includes data sheet on zinc and aluminum die casting alloys. (77)

Flame Hardening. National Forge & Ordnance Co., 4 pp, illus. Advantages gained by flame hardening large forgings. (78)

Finishes. Parker Rust Proof Co., 3 pp. Lists and describes rust preventative finishes which add to the performance qualities and improve the appearance of articles treated. (79)

Beryllium Copper Strip. Penn Precision Products, Inc., 12 pp, illus, No. 6. Suggestions on ordering beryllium copper strip. Available alloys, tempers, sizes and tolerances. (80)

Metal Fabricating. Plume & Atwood Mfg. Co., 12 pp. Explains products and describes plant, equipment and skills offered by metal fabricator. (81)

Nonmetallics. Polymer Corp. of Pennsylvania, 4 pp, illus. Describes properties and characteristics of a line of nylon, Teflon and specialty nonmetallics. (82)

Synthetic Rubber. Naugatuck Chemical Div., U. S. Rubber Co., 8 pp, illus. Gives description of eight synthetic rubber lattices and also lists the uses for which each latex was developed. (83)

Stainless and Alloy Steel Fittings. H. K. Porter Co., Watkins-Stillman Fittings Div., 8 pp, illus, No. S-1-55. Engineering data and size information on forged stainless and alloy steel fittings. (84)

Metal Fabricating. Puget Sound Fabricators, Inc., 12 pp, illus, No. F-20. Illustrates a wide variety of fabricating jobs, including use of steel and alloys up to 1 in. in thickness. (85)

Plastics Sheets and Tubing. Pyramid Plastics Inc. Price list and data on plastic tubing, pipe, rod, sheets and fittings. (86)

Powder Metal Parts. Reese Metal Products Corp., 1 p. Describes advantages of and techniques for making powder metal parts. (87)

Titanium. Rem-Cru Titanium Inc., 8 pp. Presents physical and chemical data on Rem-Cru A-110AT alloy. (88)

Rare Earth Oxides. Research Laboratories of Colorado, Inc., 1 p. Prices of commercially available rare earth oxides. (89)

Plastics Films. Reynolds Metals Co., 4 pp, illus. Brochure on Reynolon PVA/4-6 Series polyvinyl alcohol films for use in forming reinforced plastics. (90)

Roll Formed Shapes. Roll Formed Products Co., 26 pp, illus. Shows simple and complex sections being produced from both ferrous and nonferrous metals. (91)

Adhesives for Plastics and Metals. Rubber & Asbestos Corp. Data chart lists technical data, form, percentage solids, average viscosity, fastest optimum curing time, lowest optimum curing temperature and applications for 30 adhesive formulations used in bonding plastics to metals and to themselves. (92)

Aircraft Steels. Joseph T. Ryerson & Son, Inc., 68 pp. Gives information on Army, Navy and Government aircraft steel specifications. (93)

Brazing and Soldering. Selas Corp. of America, 8 pp, illus, No. S-1050. Describes automatic brazing and soldering production methods. (94)

Thread Cutting Screws. Shakeproof Div., Illinois Tool Works, 32 pp, illus. Design of screws. Detailed tables giving data on use of metals and plastics, with recommended hole sizes. (95)

Plastics Sheets. Plastics Div., Seiberling Rubber Co., 2 pp. Data on Seilon DP in transparent embossed and nonembossed sheets. (96)

Fibre Products. Spaulding Fibre Co., 16 pp. Detailed breakdown of industry applications for vulcanized fibre and laminated phenolic plastics. (97)

Ultrasonic Inspection. Sperry Products, Inc., 8 pp, illus, No. 50-105. Explains principle of ultrasonic inspection and illustrates latest types of equipment. (98)

Ceramic Insulation. Star Porcelain Co., 3 pp. Specifications on center shoulder bushings, insulating washers and bushings made of steatite ceramic. (99)

Steel Castings. Steel Founders' Society of America, 4 pp, illus, Product Design Study No. 71. Illustrates how a complex one-piece compressor cylinder was cast in steel. (100)

Gas Carburizing. Surface Combustion Corp., 7 pp, illus, No. SC-172. Discusses equipment and gives typical applications of gas carburized metals. (101)

Electroplating Data Chart. Technic Inc. A readable 8½ x 11 in. chart giving electroplating data on precious metals such as gold, palladium, platinum, rhodium and silver. (102)

Fasteners. Townsend Co., 4 pp, illus. Describes permanent fastening with rivets designed for use on any model of tubular rivet setting machine. (103)

Pipe Fittings and Flanges. Tube Turns Plastics, Inc., 12 pp, illus. Drawings and data on fittings and flanges made of unplasticized polyvinyl chloride. (104)

Electronic Materials. Tungsten & Chemical Div., Sylvania Electric Products, Inc. Series of data sheets on tungsten,

molybdenum, semiconductor, plated wire, chemical and phosphor products. (105)

Synthetic Fluids. Union Carbide & Carbon Chemicals Co., 52 pp, illus, No. 6500D. Properties, applications and characteristics of polyalkylene-glycol derivatives. (106)

Sintered Bronze Bushings. U. S. Graphite Co., Div. of Wickes Corp., 64 pp, illus. Lists sintered bronze bushings of various designs to aid in selecting the required type and size. (107)

Cleaning Metal Parts. Vic Manufacturing Co., 2 pp, illus. Describes and illustrates degreaser for cleaning metal parts. (108)

Aluminum Bronzes. W. W. Alloys, Inc., Div. of Fansteel Metallurgical Corp., 28 pp, illus, No. 15.100-1. Detailed information on aluminum bronzes. Table of physical properties and typical applications. (109)

Cleaning Abrasive. Wheelabrator Corp., 8 pp, illus, No. 89-B. Use of cast steel shot in blast cleaning and as a peening abrasive. Includes a tabular comparison of various types of metallic abrasives. (110)

Plastics Molding. R. D. Wood Co., 4 pp, illus. Describes presses for molding, laminating, polishing, curing and embossing. Also combination presses and presses for special uses. (111)

Electric Weld Tube Mills. Yoder Co., 64 pp, illus. Reviews the different tube making processes and gives complete description of the cold forming, electric welding process—its development, its possibilities and its limitations. Also discusses initial and operating costs of such mills, production speed, and minimum tonnage or footage required for profitable operation. (112)

Other Available Literature

Irons and Steels • Parts • Forms

Malleable Iron. Albion Malleable Iron Co., 15 pp, illus. A thorough analysis of malleable iron for casting, the booklet contains a definition of malleable iron, its relationships to other ferrous materials, micrographs, physical properties and relative cost figures for several parts now being manufactured. (113)

Welded Steel Tubing. Armco Steel Corp., 12 pp, illus. Characteristics and physical properties of welded steel tubing. Examples of application. (115)

Wire Parts and Metal Stampings. Art Wire & Stamping Co., 4 pp, illus, No. 875. Illustrates a variety of wire parts and small metal stampings that this company can produce. (116)

Precision Castings. Austenal Laboratories, Inc., Microcast Div., 16 pp, illus. Describes Microcast Process for manufacture of precision cast parts, including specifications and explanation. (117)

Forged Weldless Steel Rings and Flanges. Standard Steel Works Div., Baldwin-Lima-Hamilton Corp., 12 pp, No. 10,000. Discusses design advantages and cost-cutting applications of forgings in industrial processing equipment. (119)

Iron and Steel Castings. Campbell, Wyant & Cannon Foundry Co., 24 pp, illus. Describes types of gray iron and steel castings. (121)

Circular Steel Shapes. Commercial Shearing & Stamping Co., 24 pp, illus, No. P-3. Covers company's range of cold formed circular steel blanks. flanged and dished shapes, produced from stocked dies. (123)

Steel Sheets and Wire. Continental Steel Corp., 20 pp, illus. Contains sizes, tempers, shapes and finishes of wire available and describes types of steel sheet in stock. (124)

Stainless Steels. The Cooper Alloy Corp., 4 pp, illus. 1954 alloy reference chart lists chemical analyses, physical properties; recommends applications for 28 grades of cast stainless steels. Indicates ACI, AISI, SAE, ASTM and general type designations. (125)

Static and Centrifugal Castings. Duraloy Co., 16 pp, illus, No. 3354-G. Describes facilities for producing high alloy static and centrifugal castings. Engineering data on castings for heat, corrosion and abrasion resistance. (128)

Stainless Steel. Peter A. Frasse & Co., Inc., 6 pp, illus. Lists company's line of stainless steel sheet, tube and forms. Specifications given. (129)

Sponge Iron Powders. Hoeganaes Sponge Iron Corp., 6 pp, illus. Outlines principles of powder metallurgy and role of sponge iron powder in this process. (131)

Electrolytic Iron Powder. A. Johnson & Co., Inc., 30 pp, illus. Detailed account of a high purity powder with higher sintering activity, better compressibility, and a higher flow rate. Made in Sweden. (132)

Powder Metallurgy. Keystone Carbon Co., 6 pp, folder. Describes company's powdered metal products and facilities for production. (133)

Malleable Iron. Malleable Founders' Society, 4 pp, illus, No. 52. New facts on the uses of malleable iron are given. (135)

Castings. Meehanite Metal Corp. Physical specification chart for engineering design in the form of a calculating wheel. Characteristics of general engineering, heat-resisting, corrosion-resisting and wear-resisting metals. (136)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 71 and 72.

Threaded Stampings. Mohawk Mfg. Co., 2 pp, No. 851. Illustrates variety of products produced by Mohawk's stamping processes, guaranteeing uniform threaded parts with uniformly threaded holes. (137)

Metal Powder Parts. Powdered Metal Products Div., Yale & Towne Mfg. Co., 6 pp, illus, No. 352. Shows a variety of ferrous and nonferrous metal powder parts fabricated by this company. (139)

Metal Containers. Pressed Steel Tank Co., 16 pp, illus. Tells how many industries have been helped in quality production at low cost by use of Hackney Metal containers and deep drawn component parts. (140)

Zinc Coated Steel. Sharon Steel Corp., 12 pp, illus. Physical properties of hot-dipped, zinc-coated, strip steel. (143)

Spun Metal Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (144)

Clad Metals. Superior Steel Corp., 24 pp, illus. An introduction to clad metals offering a comprehensive survey of the manufacture and application of stainless, copper, brass and other clad steels. (145)

Wire Processing. Sylvania Electric Products, Inc., 12 pp, illus. Describes facilities for manufacture of fine wire and ribbon, wire and ribbon parts, and small parts plating. Chemical composition charts of materials used are included. (146)

Graphitic Steel. The Timken Roller Bearing Co., Steel & Tube Div. Data on properties and applications of graphitic steels. (147)

Small Precision Metal Parts. Torrington Co., 4 pp, illus. Illustrates the various small precision metal parts custom-made by the Specialties Div. of Torrington. (148)

Steel Castings. Unitcast Corp., ill, No. 649A. Discusses this company's testing facilities for insuring high quality production of steel castings. (149)

Tool Steel. Vanadium-Alloys Steel Co., 68 pp. New tool steel guide presenting technical data on more than 50 types of tool steel and cold finished products. (150)

Ferro-Alloys and Metals. Vanadium Corp. of America, 24 pp, ill. "The Vancoram Review" presents technical articles on applications and developments in ferro metallurgy especially concerned with vanadium alloys. (151)

Pipe and Tubing. The Wallingford Steel Co., 8 pp, ill. Stainless, carbon and alloy steel tubing for ornamental, mechanical, pressure, sanitary and aircraft use in size range from ¼-in. to 3-in. O.D. (152)

Stainless Steel Sheet and Strip. Washington Steel Corp., 4 pp. Includes types, uses, physical properties and specifications of MicoRold stainless steel sheet and strip. (153)

Stampings. Wells Specialty Co., Inc., 22 pp, illus. Facilities for stampings, dies and engineering service. (154)

Continuous Weld Pipe. Youngstown

Manufacturers' Literature

Sheet and Tube Co., 2 pp. Folder gives complete data on Yoloy continuous weld standard pipe and line pipe, and its corrosion resistance. (156)

Nonferrous Metals • Parts • Forms

Aluminum Applications. Aluminum Co. of America, 80 pp, illus. Process applications of aluminum; performance of aluminum with various chemicals; information on designing aluminum processing equipment. (159)

Machining Copper. American Brass Co., 32 pp, illus, No. B-3. Suggestions for machining copper, brass, bronze and nickel silver including tool rakes, clearances, cutting speeds and feeds. Tables give physical properties, constants and specifications of Anaconda metals and alloys. (161)

Engineering Bronzes. American Crucible Products Co., 12 pp, ill. Includes complete data on facilities, technical information, case histories and applications of Promet bronzes. (162)

Pre-Finished Metals. American Nickeloid Co., 24 pp, illus. Fabrication techniques, uses and properties of prefinished metals are described, along with case histories of applications in various manufacturing fields. (163)

Beryllium-Copper Strip. American Silver Co., Inc., Industrial Div., 4 pp. Basic information on principal beryllium-copper alloys. Charts and graphs describe engineering properties and metal tempers. (164)

Zinc and Corrosion. American Zinc Institute, 32 pp, illus. Numerous case histories dealing with the corrosion control characteristics of zinc coatings, pigments, and anodes. (165)

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, ill. Informative article on precision investment castings. Includes table of ferrous and nonferrous alloys recommended as most adaptable for this process. (166)

Precision Castings. Atlantic Casting & Engineering Corp., 12 pp, illus. How to obtain nonferrous castings cast to ordinary machining tolerances. Describes process and gives alloy specifications. (167)

Magnesium and Aluminum Alloy Castings. Bendix Foundries, 4 pp. Facilities for sand, die, shell, plaster and permanent mold castings of magnesium or aluminum. (168)

Duplex Tubing. Bridgeport Brass Co., 14 pp, illus, No. 1954. Explains the use of Duplex tubes for heat exchangers and condensers in which internal and external corrosion conditions differ. (169)

Bimetals. W. M. Chace Co., 36 pp, ill. Describes and explains 22 uses of bimetals as actuating elements in temperature responsive devices. (170)

Copper. Copper & Brass Research Assn. BDSA report on booklet "Copper Today and Tommorow" discuss U. S. copper supplies. (171)

Electroforming. Gar Precision Parts, Inc., 4 pp, ill. Process permits exact reproduction of intricate details on sheet or complex forms using permanent or expendable mandrels. (172)

Bi-Metallic Construction. Arthur Tickle Engineering Works, 8 pp, illus. Description of Alumibond process for molecularly bonding aluminum and its alloys to iron and steel and their alloys. (174)

Aluminum Wire. U. S. Rubber Co., 30 pp, tables. A handbook describing the uses and properties of aluminum for power and lighting wire. (175)

Magnesium and Aluminum Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" shows company's facilities for custom-making aluminum and magnesium castings. (176)

Bonded Bi-Metallics. Fairchild Engine & Airplane Corp., 4 pp, illus. News of Al-Fin process and its application to a variety of fields. (177)

Metal Stampings. Geuder, Paeschke & Frey Co., 12 pp, ill. Detailed description of this firm's metal fabricating, finishing and assembling facilities as a subcontractor for defense parts. (178)

Investment Casting. Gray-Syracuse, Inc., 4 pp, ill. Parts of precision cast brass, bronze, beryllium copper and steel. (179)

Copper and Brass Tubing. H & H Tube & Mfg. Co. Describes a complete line of seamless braze and lock seam copper and brass tubing. (180)

Double Headed Parts. John Hassall, Inc. Catalog shows numerous double headed parts, indicating applications and suggesting other applications of double heading operations. (181)

Long Wearing Machine Parts. Haynes Stellite Co., 23 pp, ill. Booklet describes a few of the many machinery parts made of Haynes alloys. Also contains over 60 tables and photographs showing some of the sizes and shapes in which these alloy parts are being used. (182)

Laminated Metals. Improved Seamless Wire Co., Inc., 6 pp, ill. Describes the importance and applications of laminated metals to modern industry. (183)

Beryllium Copper Springs. Instrument Specialties Co., Inc., 16 pp, illus, No. 9. Catalog of company's stock of compression springs, flat springs, strip springs, contact strips and contact rings. (184)

Investment Castings. Investment Casting Co., 12 pp, ill. Second edition explains how investment casting is used to eliminate machining and assembly costs and minimize waste metals. (185)

Lithium Metals and Compounds. Lithium Corp. of America. Data sheets on properties and uses of lithium metal and organic and inorganic lithium compounds for metal treatment, ceramic modifications, welding, etc. (186)

Brass Powder Parts. New Jersey Zinc Co., 4 pp, illus. Describes applications of brass powder parts in self-developing cameras, rotors, drive bars. (189)

Die Castings. Precision Castings Co., Inc., 24 pp, ill. Describes company's integrated facilities for quantity production of aluminum, magnesium and zinc die castings. (191)

Zinc Die Casting. St. Joseph Lead Co., 24 pp, ill. Discusses role of zinc as a base metal for die casting alloys and lists the variety of commercial finishes for zinc base die castings. (194)

Strip and Sheet Brass. Scovill Mfg. Co., 4 pp, ill. Continuous-cast strip and sheet brasses and bronzes. (196)

Aluminum Alloy Chart. U. S. Reduction Co. Practical and handy sliding chart of USCO aluminum alloys giving casting and physical data. (197)

Light Metal Forgings. Wyman-Gordon Products Corp., 4 pp, ill. Announces the availability of large-size light alloy forgings, particularly those of magnesium and 75-S aluminum. (198)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (199)

Nonmetallic Materials • Parts • Forms

Silicone Rubber. Acushnet Process Co., 8 pp, ill, No. B. Describes method of custom-compounding silicone rubber. Gives property ratings, molding techniques, mold design and design specifications. (201)

Honeycomb Material. Aircomb Section, Douglas Aircraft Co., Inc. Development of Aircomb, a honeycomb structure of Kraft paper impregnated with a phenolic resin. Precut in any thickness from 1/16 to 5 in., it is said to be 16 times as rigid as an equal weight of steel, durable, fire-resistant, pest-resistant, has excellent insulation, soundproofing properties. (202)

Wool Felt. American Felt Co. Includes Dept. of Commerce bulletin Commercial Standard 185-52 Wool Felt. 47 reference samples of industrial felts. (203)

Plastic Pipe, Fittings and Valves. American Hard Rubber Co., 6 pp, illus, No. 80-A. Corrosion-resistant plastic pipe with good impact strength and toughness. Physical properties, chemical resistance tables and installation and fabrication data. (204)

Ceramics. American Lava Corp., 4 pp, illus, No. 551. Revised charts of mechanical and electrical properties of "AlsiMag" technical ceramics. (205)

Extruded Plastics. Anchor Plastics Co. 12 pp, ill. Applications of thermoplastic rods, tubes and shapes. Summary of properties of plastics materials with usage table. (206)

Fiber Glass Ducting. Arrowhead Rubber Co., 16 pp, ill, No. 503. Detailed engineering data on descriptions and ap-

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 71 and 72.

plications of this company's Fiberglas flexible and rigid ducting. (208)

Corrosion Proof Cements. Atlas Mineral Products Co., No. 5-1. Handy charts cover a complete line of resin, sulfur, silicate and asphaltic cements, and show how to select the correct cement for a specific application. (209)

Glass Fiber Sleeving. Bentley-Harris Mfg. Co., 4 pp. Describes new Fiberglas tubing and sleeving with high physical and dielectric properties. (211)

Refractories. Carborundum Co., 24 pp, illus. Describes group of refractories having exceptional hardness, strength and heat resistance. (212)

Thermosetting Resin. Celanese Corp. of America, Folder M-1, 6 pp. Physical properties and process characteristics of the MR series liquid low-pressure thermosetting resins for laminating, casting, coating, impregnating and molding. Folder M-2, 6 pp. Describes the Marco method for producing laminates with low-cost mating molds. (213)

Compounded Elastomers. Chicago Rawhide Mfg. Co., 32 pp, ill. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (214)

Coated Fabrics. Connecticut Hard Rubber Co. Uses, chemical, electrical and mechanical properties, and availability of heat resistant silicone rubber coated glass fabrics. (216)

Electrical Motor Insulation. Dobeckmun Co., 4 pp, illus. Mylar, cellulose acetate and electrical papers for electrical motor slot cell insulation, phase separation and layer insulation. Physical and electrical properties and typical applications. (217)

Synthetic Elastomers. Fabrics Div., E. I. du Pont de Nemours & Co., 7 pp, illus. Properties and uses of various grades of Fairprene elastic composition for sheet stock, coated fabrics, and adhesives. (218)

Felt. The Felters Co., 22 pp. Design properties, selection and applications of felt and felt products. (220)

Polyvinyl Chloride. Firestone Plastics Co., 8 pp. Mechanical, thermal, electrical and chemical resistance properties of unplasticized polyvinyl chloride. (221)

Custom Molding. General Electric Co., 6 pp, ill, No. CDP-661. Folder describes company's mold-making facilities at Decatur, Ill., and Taunton, Mass. (223)

Industrial Laminates. General Electric Co., 8 pp. How to select particular grade of laminated plastic sheet applicable to specific design problems. Charts give description, properties and applications. (224)

Silicones. General Electric Co., 12 pp, illus. A round-up of the "Silicone Story"—the forms they take, what they do, and their four basic properties illustrated. (225)

Flexible Foamed-In-Place Resins. Isocyanate Products, Inc., 4 pp, No. 1. Describes use, applications, and properties of Isofoam F, a flexible foamed-in-place, polyisocyanate, expansible resin. (228)

Expanded Plastics. Koppers Co., Inc., 26 pp, ill. How to mold foamed polystyrene parts. Properties, data sheet and applications given. (230)

Vibration Control Materials. Lord Manufacturing Co., 12 pp, ill. Stock list of vibration-control shock mounts and couplings. (231)

Refractory Porcelain. McDanel Refractory Porcelain Co., 36 pp, ill. Catalog of high temperature porcelain products, with physical, mechanical, and electrical properties. (232)

Glass and Ceramic Parts. Mansol Ceramics Co., 16 pp, illus. Glass preforms for hermetic seals, adhesives steatite preform and multiform production facilities. (233)

Plastic Resins and Compounds. Naugatuck Chemical Div., U. S. Rubber Co., 8 pp, ill. Vinyl, polyester and elastomeric resins and compounds, applications, properties and processing. (236)

Fiber Glass. Pittsburgh Plate Glass Co., 4 pp, ill. Lists advantages of using glass fiber for sound and heat insulation applications. (237)

Carbon Graphite. Pure Carbon Co., Inc., 32 pp, ill, No. 52. Technical data on description, properties, applications and specifications of Purebon carbon graphite. (238)

Plastics Fabrication. Regal Plastic Co., 4 pp, ill. Custom contract service from designing and engineering to finished part, assembly or product—using plastic sheets, rods, tubes, reinforced fiberglass. Includes special bulletin on cases. (239)

Polyester Resins. Reichhold Chemicals, Inc. Brochure includes 11 technical bulletins of 2 to 6 pages each describing the Polylite line of liquid thermosetting polyester resins. The bulletins cover molding characteristics and physical properties of 10 resins of various heat and light resistant grades, suitable for use in glass fiber reinforced applications. (240)

Chemically Resistant Products. Resistoflex Corp., 6 pp, illus. Folder on chemically resistant industrial hose and plastics. (241)

Reinforced Plastics. Strick Plastics Corp., 4 pp, illus. Describes reinforced polyester laminate with good thermal, electrical, chemical and mechanical properties. Typical applications given. (243)

Nylon Lined Bearings. Thomson Industries, Inc., 5 pp. Metal bearing case with nylon liner extends service properties of nylon as bearing material. (255)

Molded and Extruded Rubber Parts. Tver Rubber Co., 8 pp, ill, No. 1P52. Detailed information on various types of molded and extruded parts of natural and synthetic rubber. (244)

Plastisol. United Chromium Inc., 4 pp, ill. Physical, chemical properties of Unichrome plastisol compounds used for coating, casting or molding. (245)

Rigidized Metal Bonded Plywood. United States Plywood Corp., 8 pp, ill. Gives special features, advantages and wide variety of uses for Armoply, sheet metal bonded plywood. (246)

Flexible Plastic Tubing. U. S. Stoneware Co., 28 pp, illus. Gives properties and uses of extruded vinyl plastic tubing available in semi-rigid or flexible sheets, tubing or solid cord. (247)

Industrial Fibers and Textiles. Wellington Sears Co., 26 pp, illus. Properties of industrial textile fibers, including cotton, rayon, acetate, nylon, acrylic, polyester, glass, vinyl and protein. Defines yarn designations, basic weaves and variations as used in fabrics. How fabrics are selected for use with rubber; as coated fabrics; in laminated plastics; for filtration purposes; and other applications. (248)

Thermoplastics. Westchester Plastics Inc., 4 pp. Advantages of using this company's services for all types of coloring in molding and extruding of plastics. (249)

Synthetic Rubber Products. Western Felt Works, Acadia Synthetic Products Div., 6 pp, ill. Describes various types of molded, extruded, roll die cut and lathe cut synthetic rubber parts and sheets. (250)

Laminated Plastics. Westinghouse Electric Corp., 50 pp. Catalog on industrial Micarta covering all grades and forms in which Micarta is supplied, and the chemical, mechanical and electrical properties of each. Machining data gives fabrication information. (251)

Friction or Damper Parts. World Bestos, Div. of Firestone Tire & Rubber Co., 4 pp, illus. Available molded parts—brake lining and blocks, transmission linings, clutch facings, thrust washers, etc. (254)

Finishes • Cleaning • Finishing

Barrel Finishing. The Abbott Ball Co., 8 pp, ill. Describes barrel finishing techniques with a new design tumbling barrel. (256)

Hot Dip Galvanized Coatings. American Hot Dip Galvanizer's Association Inc., 16 pp, ill. Description of hot dip galvanizing process in industrial and consumer item applications. (257)

Zinc-Plate Bright Dip. The Chemical Corp. Information on Luster-On Utility-25 bright dip for zinc-plated surfaces. Highly resistant to corrosion. (258)

Spray Painting. Conforming Matrix Corp., 5 pp, ill. Gives description, uses, and advantages of this firm's spraying masks, mask washing machine, and spray painting equipment. (259)

Brush Plating. Dalic Metachemical Ltd., 4 pp, illus. Presents advantages of brush plating with the Dalic process. (260)

Enamel. Maas & Waldstein Co., 2 pp, No. 520. Data sheet for industrial multicolored enamels. (262)

Manufacturers' Literature

Protective Coatings. Magic Chemical Co. Revised catalog describes "Magic-Vulc" abrasion-resistant rubber lining and its applications. (263)

Barrel Finishing. Minnesota Mining & Mfg. Co., 12 pp, illus. How barrel finishing works, when to use this process, and what operations barrel finishing performs. A supplementary booklet discusses abrasive chips and compounds for barrel finishing. (265)

Metal Cleaner. Niagara Alkalai Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (266)

Zinc Phosphate Coatings. Oakite Products, Inc., 10 pp, illus. Describes corrosion-resistant zinc phosphate coating for steel, which improves adhesion between paint and metal. (267)

Precision Plating. Standard Pressed Steel Co., 32 pp, illus. Describes company's plating facilities and discusses some precautions to be taken to insure close tolerances. (268)

Burnishing. Tumb-L-Matic Inc., No. BB-52. Features operation and specifications of conventional wooden and molded barrels of high abrasion resistance material. (269)

Methods and Equipment

Heat Treating. Ajax Electric Co., 8 pp, illus, No. 500. Traces development of austempering and martempering, discusses principle of S-curve, and gives instructions for selecting specific heat treatment. (271)

Precision Optical Instrument. American Cystoscope Makers Inc. Features and typical uses of ACMI borescopes for precision inspection. (272)

Brazing Alloys. The American Platinum Works. 46 pp, ill. Handy-sized manual gives detailed description of the brazing process, the alloys used, design of joints and other considerations for successful joining. (273)

Radium Radiography. Atomic Energy of Canada, Ltd., Commercial Products Div., P. O. Box 379, Ottawa, Canada, 71 pp, ill, price $2.00. Detailed theory, equipment and applications of radium radiography. Available directly from Atomic Energy of Canada.

Industrial X-ray Equipment. Balteau Electric Corp., 2 pp, ill. Portable x-ray unit of wide voltage range from radiographing spot welds and light materials to penetrating over 1 in. of steel. (274)

Spectrograph. Bausch & Lomb Optical Co., 14 pp. Describes a 1.5 meter stigmatic spectrograph for laboratory use. (275)

Black Light. Black Light Corp. of America, 65 pp, illus. Long wave ultra-violet light for display, industrial inspection, flaw detection, etc. Case histories plus data on research in this field. (276)

Chromium Molybdenum Welding. Champion Rivet Co., 13 pp, No. CM-55. Low hydrogen welding electrodes for chromium molybdenum alloy steels. Data includes physical and mechanical properties of welds, chemical analysis of weld deposit, and discussion of welding procedure. (277)

Screws with Integral Washer. Continental Screw Co., 6 pp, illus. Metal and plastic applications of a screw with the lock washer an integral part of screw head. (278)

Magnifying Contour Projector. Eastman Kodak Co., 8 pp, illus, No. FI-23. Operating principle, applications, features, specifications and accessories of this firm's contour projector. (279)

Muffles and Retorts. Electro-Alloys Div., American Brake Shoe Co., 6 pp, illus, No. T-239. Describes company's high heat-resistant muffles and retorts and outlines corrosion and abrasion resistance features. (280)

Fasteners. General Tire & Rubber Co., illus, folder. Self-mounting fasteners for shock-mounting metal, plastic and glass panes and components. (282)

Inserts. Groov-Pin Corp. Self tapping insert used as original equipment and for salvage and repair of stripped threads. (283)

Rivet-Type Fasteners. B. F. Goodrich Co., Rivnut Div. Cardboard "demonstrator" illustrates working principle of Rivnuts, their construction and applications. (284)

Silver-Brazing Alloys. Handy & Harman, 26 pp, illus, No. 20. Low temperature silver alloy brazing. (285)

Fasteners. H. M. Harper Co., 8 pp, illus, Vol. 19, No. 2. Various case histories of the applications of Harper's fasteners, emphasizing corrosion-resistant bolts. (286)

Heat-Treating Furnaces. Hevi Duty Electric Co., 8 pp, illus, No. 653. Describes furnaces for annealing, stress relieving, nitriding, etc. (287)

X-ray Generator. High Voltage Engineering Corp., No. JR. New model Van de Graaff one-million-volt x-ray generator for heavy duty radiography on steel thicknesses up to 4½ in. (288)

Carbon Control. Leeds & Northrup Co., 10 pp, illus, No. Td4-620 (2) 1954. Principle and operation of automatic measurement and control of active carbon inside furnace retorts during heat treating cycles. (289)

Tubular Furnaces. Marshall Products Co., 4 pp, illus. Discusses both the creep test and tensile test models of Marshall tubular furnaces, as well as control panels and radial brackets. Includes specifications. (290)

Fasteners. Milford Rivet & Machine Co., 12 pp, illus, No. MM52. Detailed information on an integrated service of fastener research, design, engineering and production collaboration. (560)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 71 and 72.

Induction Heating. The Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (561)

Surface Pyrometer. Pyrometer Instrument Co., Inc., 6 pp, illus, No. 168. Complete data on the Pyro surface pyrometer for quick and accurate surface and sub-surface temperature readings. (562)

Vacuum Unit. Radio Corp. of America, Scientific Instruments Section, 4 pp, illus, No. EM-61. Features applications, description and specifications of vacuum unit for vacuum deposition of metals and laboratory work. (563)

Cold Treatment Equipment. Revco Inc., 2 pp, illus. Describes cold treating cabinets for seasoning gages and precision tools, for testing, for shrink fits, and for aircraft rivet applications. (564)

Torsion Tester. Riehle Testing Machines Div., American Machine & Metals, Inc., 8 pp, illus. Machines for twist-testing components, assemblies, sample stock and wire. (565)

Lock Screw Fasteners. Russell, Burdsall & Ward Bolt & Nut Co., 3 pp, illus. Features advantages and dimensions of this company's spin-lock screws. (566)

Fastener Demonstrator. Set Screw & Mfg. Co. Cardboard demonstrator shows the way Zip-Grip set screws lock themselves into place. (567)

Fasteners. Simmons Fastener Corp. Literature describes fasteners especially designed for use in construction where easy demountability is required. (568)

Heat Treating Equipment. Stanwood Corp., 4 pp. Brief description of types of heat treating equipment with suggested applications. (570)

Temperature-Sensitive Crayons. Tempil Corp. Revised instructions for using "Tempilsticks," with a chart of temperature ratings available. (571)

Engineering Tables. U. S. Testing Co., 109 pp, illus. Selected chemical, physical, engineering, plastics, bacteriological, leather, psychometric and textile tables and charts arranged for easy reference. Write on company letterhead to U. S. Testing Co., Inc., 1415 Park Ave, Hoboken, N. J.

Brazing Alloys. United Wire & Supply Co, 3 pp, illus. Wire brazing aluminum for low temperature brazing of various metals and alloys. (572)

Resistance Welding. Unitek Corp., 6 pp. Describes bench mounted precision resistance welder for joining small metal assemblies in electronic, instruments, and ordnance products. (573)

Heat-Treating Furnaces. Waltz Furnace Co., illus. Contains descriptive material on all types of industrial furnaces for heat treating, enameling, cyaniding and annealing in controlled and regular atmosphere. (574)

Hardness Testers. Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. Engineering data, uses and design features of Rockwell hardness testers. (575)

One point of view

The Design Engineering Show

A new industrial exposition will make its debut in Philadelphia's Convention Hall, May 14th through 17th. Known as the "Design Engineering Show", it will be devoted exclusively to the interests and problems of product planners, designers and engineering men in the original equipment and other hard goods manufacturing industries. The exhibitors at this new show will be the producers and fabricators of engineering materials, parts and finishes, and the manufacturers of components and mechanical assemblies, all of which are used in product design.

Since M&M is the materials magazine of the design engineering field, we are naturally most interested in the exhibits featuring materials, parts and finishes. These exhibits will comprise about half the booths, offering you an excellent opportunity to examine new and existing ferrous and nonferrous metals and alloys, nonmetallic materials, parts and shapes, finishes and coatings. Technical specialists will be on hand to discuss with you the possible applications of these engineering materials in your products. Our own booth will display actual samples of new materials, parts and coatings covered in recent M&M articles. A wide range of mechanical, electrical, hydraulic and pneumatic components will also be exhibited, as the scope of the show covers the entire field of design engineering.

We strongly recommend to you, our readers, that you attend the "Design Engineering Show", since it brings together in one place a wider range of kinds and forms of engineering materials than any other industrial exposition, together with the expert advice which leads to their most effective use in product design.

In conjunction with the show, a series of technical sessions will be held during a three-day period, sponsored by the Machine Design Division of the American Society of Mechanical Engineers. You will have an opportunity to listen to and join in discussions of problems common to the design engineering field, including materials-selection problems. The program is being arranged by the editors of four leading publications in the design engineering field; *Electrical Manufacturing*, *Machine Design*, *Materials & Methods*, and *Product Engineering*.

M&M readers should find the new Design Engineering Show and Conference a rewarding experience and we hope many of you will pay us a visit in our booth, #303. Further details will be found on page 13 of this issue, and complete information may be obtained from the owners and sponsors, Clapp & Poliak, Inc., 341 Madison Avenue, New York 17, N. Y.

Ultra High Strength Steels

Present ➡

and Future ➡

TABLE 1

Type	AMS No.**	Average Composition, %							Approx Ten Str Level, psi
		C	Mn	Si	Ni	Cr	Mo	V	
Used in 1955 Production Airplanes									
4340	6415	.40	.75	*	1.83	.80	.25	—	270,000
4330 Modified	6427	.30	.90	*	1.83	.85	.43	.08	250,000
HS-220	6407	.30	.70	.55	2.05	1.20	.45	—	230,000
Hy-Tuf	6418	.25	1.35	1.50	1.83	.30	.40	—	230,000
Under Investigation									
4350		.50	.75	*	1.83	.80	.25	—	300,000
HS-260		.40	.85	.60	2.20	1.45	.50	—	290,000
Super Hy-Tuf		.40	1.30	2.30	—	1.40	.35	.20	300,000
Hi C Super Hy-Tuf		.47	1.28	2.42	—	1.11	.42	.25	325,000
98B40 Modified		.40	.75	*	.85	.80	.20	Boron	290,000
USS Strux		.43	.90	.55	.75	.90	.55	Boron	290,000
Tricent		.43	.80	1.60	1.83	.85	.38	.08	300,000
Super Tricent		.55	.80	2.10	3.60	.90	.50	--	340,000

***Aeronautical Materials Specifications (SAE)*

**Normal silicon 0.20-0.35%*

Can steel producers develop a 350,000 psi steel? Present indications point to a "yes" answer. Already 270,000 psi steels have been used in production aircraft. Steels with strengths up to 340,000 psi are now being tested.

by J. W. Sands and O. O. Miller, *International Nickel Co., Inc.*

■ Steel can be processed to much higher strengths than are usually employed for structural components. However, the impression that high strength and hardness are always associated with dangerous brittleness formerly restricted steel's use to moderate strength levels, even when an improved strength-to-weight ratio would have been a distinct advantage.

In the aircraft industry this generally accepted philosophy resulted in tacit agreement that steel airframe parts would be unacceptable unless tempered at temperatures above 800 F after quenching. This requirement automatically limited the maximum strength level to a range of 180,000 to 200,000 psi. Under these conditions, aircraft quality type 4340 nickel-chromium-molybdenum steel, oil quenched and tempered at about 900 F, has become the most commonly used material for important steel components.

Because of this brittleness bugaboo, no efforts were made to break through the 200,000 psi ceiling for many years. Meanwhile intensive efforts were devoted to increasing the strength of the other aircraft materials, aluminum, magnesium, and more recently titanium, by every means which could be devised. When these efforts produced strength-weight ratios approaching that of the conventionally heat-treated steel, aircraft designers began to give serious consideration to the reserve strength inherent in steel and the minimum tempering-temperature obstacle was quickly demolished.

In designing steels for important airframe parts, one of the first requisites is a degree of hardenability insuring virtually full martensitic response to quenching in relatively heavy sections. This is necessary to develop

full strength and to avoid the depreciation of accompanying properties usually associated with "slack" quenching. Consequently all steels proposed for the ultra high strength field produce a substantially horizontal line in the standard end-quench hardenability test.

The first steel accepted by the aircraft industry for service above the 200,000 psi tensile strength level was developed by the Crucible Steel Co. of America. This steel, Hy-Tuf, develops tensile strengths up to 240,000 psi together with excellent ductility and toughness. Other steels followed, and there are currently at least four ultra high strength steels employed in production aircraft. Others are undergoing extensive testing and evaulation. All of them have one point in common; they are tempered *below* 800 F. Average compositions and approximate strength levels of these steels are given in Table 1.

The only steel now in service in the current highest strength bracket, 260,000 to 280,000 psi, is the original 4340, changed only in heat treatment. This circumstance arises from the fact that the ultra high strength steel problem has been approached by two avenues.

Two approaches

One school, sparked by the Lockheed Aircraft Co., decided that the standard material, with its long history of reliability, should not be abandoned until its full potentialities had been probed. A comprehensive testing program convinced them that the heat treatment could be modified to achieve a large increase in strength without loss of integrity, and the strength level was advanced from 190,000 to 270,000 psi in a single step.

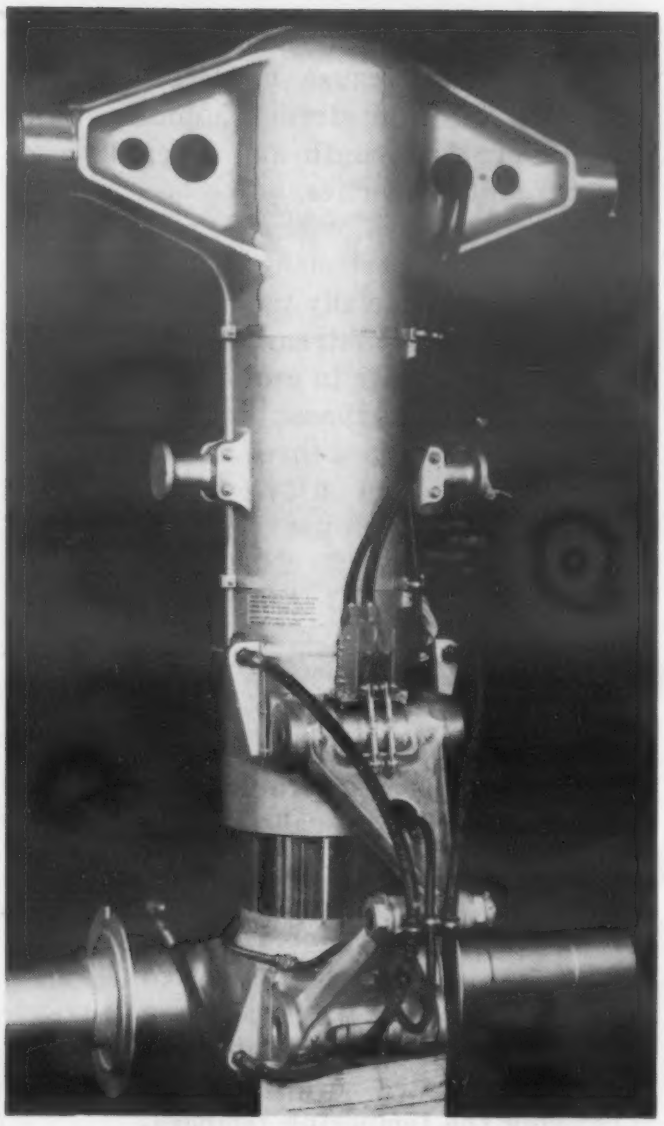
This strength represents the feasible maximum average for 4340. It requires a reduction in tempering temperature to 400 to 450 F depending upon the individual heat. Somewhat higher tensile strength can be developed by further reduction of tempering temperature but the unrelieved residual stresses existing after such treatment cause unacceptable loss in yield strength, ductility, impact strength and other concomitant properties.

The other school deemed it preferable to develop steels with alloy compositions especially tailored to provide increased strength with little or no decrease in established ductility and toughness factors. As a result there are three rather sharply defined ultra high strength brackets in use: 1) 220,000 to 240,000 psi, 2) 240,000 to 260,000 psi, and 3) 260,000 to 280,000 psi.

Embrittlement problem

A major cause of the fear of low tempering temperatures is the existence of a so-called *500 F embrittlement range* in the tempering of quenched steel. When conventional Charpy or Izod impact test values are plotted against tempering temperature, a minimum impact resistance is usually indicated near 500 F. Lowering the tempering temperature of 4340 steel from about 900

Ultra high strength steel *landing gear is used in this Boeing B-47 Stratojet bomber.*



Landing gear *produced from 4340 steel, heat treated to the 180,000/ 200,000 psi strength level for use on Boeing airplane.*

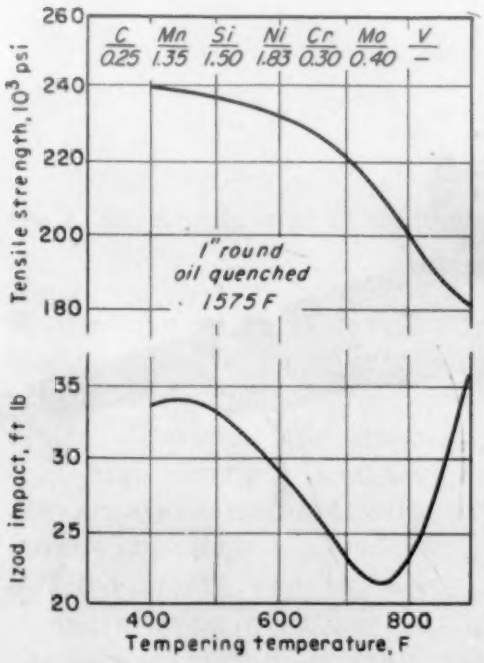
F to about 400 F skips this embrittlement range. To secure strengths between 200,000 and 270,000 psi with 4340, the steel would require tempering in the 500 to 800 F range. Therefore, new compositions for use in the intermediate strength range had to be designed which could be safely tempered in what was heretofore considered the danger zone.

At a given strength the best concomitant properties are obtained with the lowest feasible carbon content and the percentage of this element was in all cases lowered from 0.40 to 0.30% or below. From this point on, procedure differed. Republic Steel Corp. in association with Bendix Aviation Corp. developed a modified 4330 in which the standard 4300 composition was altered by increasing the molybdenum content and adding a small percentage of vanadium. As a result, impact performance is improved and the steel shows better Charpy values than 4340 at both 230,000 and 250,000 psi tensile strength.

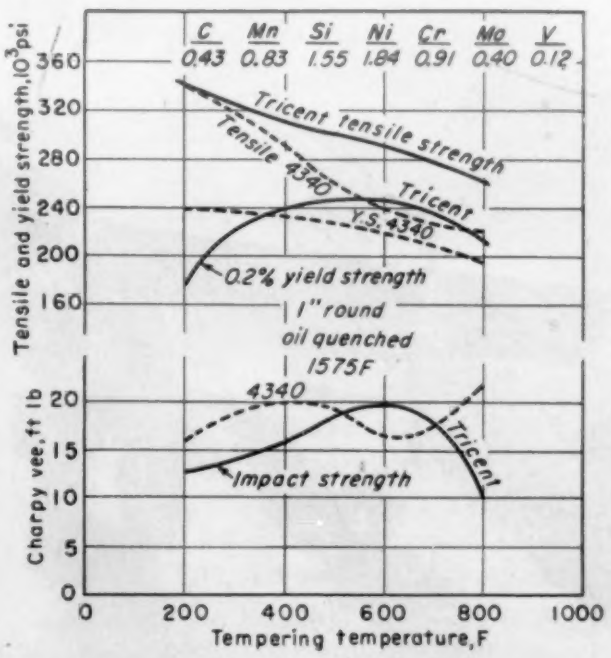
On the other hand, the first ultra high strength steel, Hy-Tuf, took advantage of unusual characteristics imparted by silicon to quenched and tempered steels. Allten and Payson showed that increasing amounts of silicon tend to retard softening resulting from increasing tempering temperature especially in the range of 400 to 600 F. Thus, a steel containing 1.5 to 2.0% silicon can be tempered at around 600 F to provide hardness and strength equivalent to that of a similar steel of normal silicon content tempered at a much lower temperature. The higher tempering temperature allows more complete relief of residual quenching stresses with consequent improvement in yield strength and ductility.

Ordinarily a 600 F tempering temperature would have the serious disadvantage of throwing a steel into the very worst portion of the impact embrittlement range. Fortunately, silicon serves also to shift the initiation of this embrittlement to higher temperatures and 600 F becomes about the best, instead of the worst, temperature from the impact standpoint also.

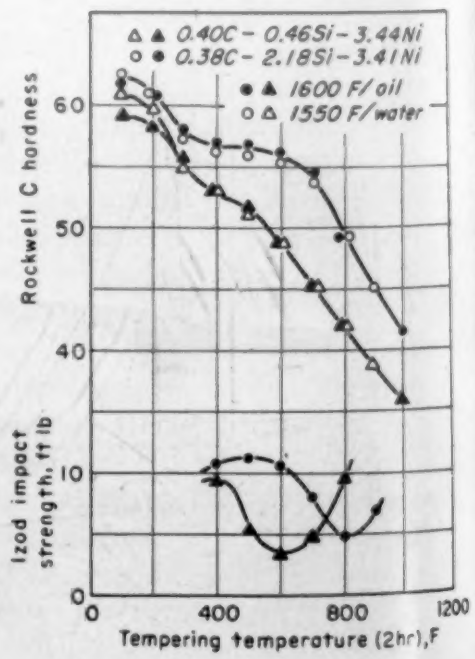
By combining a high silicon content with other compositional modifications — increased manganese and molybdenum, de-



Effect of tempering temperature on the tensile and impact strengths of Hy-Tuf. (Payson and Nehrenberg)



Effect of tempering temperature on the tensile and impact properties of two steels. (Tricent data from Bethlehem Steel Co.; 4340 data from Syracuse Univ.)



Effect of silicon content on hardness and impact strength of 3% nickel steels, refrigerated after quenching. (Allten and Payson)

creased chromium, and a reduction in carbon content from a nominal 0.40 to 0.25%—the sponsors of Hy-Tuf were able to increase the operating tensile strength level to an average 230,000 psi with actual improvement in the associated properties.

The remaining commercial steel, HS-220, was developed by the Timken Steel and Tube Co. It is a lower carbon modification of 4300 in which partial use is made of the silicon effect. Its properties are similar to those of the Republic-Bendix modified 4330 (AMS 6427). However, it is reported to be easier to meet minimum impact specifications in production with this steel than with AMS 6427.

Other steels, proposed for the ultra high strength field, are under investigation, although they are not now employed in actual production. Representative mechanical properties are given in a table with those of the four established steels.

TABLE 2—REPRESENTATIVE MECHANICAL PROPERTIES OF PROPOSED AND ESTABLISHED ULTRA HIGH STRENGTH STEELS

Steel	Ten Str, psi	Yld Str, (0.2%) psi	Elong % (2 in.)	Red of Area, %	Charpy V-Notch Impact, ft lb	Temper. Temp, F
*4340 (Usual Std Heat Treat)	190,000	180,000	15	49	27	920
*4340 (Lockheed Heat Treat)	270,000	212,000	10	35	19	450
4350	317,500	244,000	8	15	11	400
*Mod 4330 (AMS 6427) High Temper	235,000	203,000	11	44	18	650
*Mod 4330 (AMS 6427) Low Temper	255,000	209,000	10	42	17	475
*HS-220 (AMS 6407)	237,000	195,000	11	42	16	610
HS-260	290,000	—	—	—	—	—
*Hy-Tuf	230,000	190,000	13	49	30	550
Super Hy-Tuf	294,000	241,000	10	35	14	550
Hi C Super Hy-Tuf	325,000	—	—	24	10	500
Mod 98B40	287,000	236,000	7	28	13	480
USS Strux	290,000	—	—	—	—	—
Tricent	297,000	242,000	8	23	18	500
Super Tricent	342,000	—	—	—	12	400

**Currently used in production aircraft*

TABLE 3—EFFECT OF SILICON ON PROPERTIES OF 4340 STEEL TEMPERED AT 500 F

	Normal Silicon	1.5% Silicon
Rockwell hardness	C 51	C 54.5
Tensile strength, psi	260,000	300,000
True fracture stress, psi	337,000	400,000
Yield stress, (0.2%) psi	230,000	256,000
Proportional limit, psi	220,000	220,000
Elastic limit, psi	107,000	102,000
Elongation, % (2 in.)	6.7	6.3
Reduction of area, %	40	40
Charpy impact strength (V-notch), ft lb	14.3	15.9

Data on Tricent

All of the non-established steels are reaching for strengths higher than any currently employed and have reverted of necessity to carbon contents of at least 0.40%. They indicate that efforts will be made to achieve eventually the maximum strength obtainable in heat-treated steels, which may be in the neighborhood of 350,000 psi.

Of the new steels listed, the authors have been able to collect the most data for Tricent steel, since it was originated in the International Nickel Co. Research Laboratory. This steel is based on combining three of the features of the established steels to raise the practicable tensile-strength to the 290,000 to 310,000 psi bracket. The name is intended to suggest this 300 kips per sq in. strength level. The three features comprise: 1) retention of 0.40% carbon content, as in 4340; 2) modification of the 4300 chemistry, as in AMS 6427 and HS-220; and 3) the use of a high silicon content, as in Hy-Tuf.

Laboratory pilot heats gave encouraging results on the basis of which the Bethlehem Steel Co. produced a seven-ton electric-furnace heat of aircraft quality steel of the composition indicated as optimum. Tests of this steel confirmed the laboratory predictions. Maximum yield strength and resistance to impact were reached simultaneously in the 500 to 600 F tempering range, as shown in center figure, p 96.

The soundness of the concept of adding silicon to permit the use of a relatively high tempering temperature to attain high strength without embrittlement has received strong support from recent research carried out by Shih, Averbach and Cohen. In this investigation the silicon content of standard 4340 was raised to 1.5% without varying the chemical composition otherwise. Properties of tempered steels with normal and high silicon content are given in Table 3. After tempering at 500 F, the modified steel shows a 40,000 psi gain in tensile strength with no reduction in impact strength.

To clarify the ultra high strength picture, Wright Air Development Center sponsored a mechanical testing program of large landing gear forgings made of various steels commercially heat treated to high-strength levels. The steels selected were 4340, 4330 modified, HS-220, Tricent and modified 98B40. The latter is a relatively lightly alloyed steel treated with boron to impart added hardenability. Hy-Tuf was not included since it had already been proved acceptable.

The main column of a B-47 landing gear, forged in closed dies from a 15 in. round-cornered square billet weighing about a ton was selected for testing. The

TABLE 4—PROPERTIES OF B-47 LANDING GEAR MAIN COLUMN FORGINGS

	Test Direction	Steel Type							
		4340		Modified 4330		HS-220	Modified 98B40		Tri-cent
Tempering Temp, F		920	450	650	475	610	575	480	500
Tensile str, 1000 psi	Long	191	272	236	257	237	256	287	297
	Trans	191	272	239	255	238	257	293	296
Notch Tensile str, 1000 psi	Long	281	286	296	298	292	301	274	303
	Trans	267	277	280	288	282	304	268	262
Yield str (0.2%), 1000 psi	Long	180	212	203	209	195	214	236	242
	Trans	181	212	203	206	199	212	238	239
Elong, %	Long	14.6	10.4	10.9	10.9	10.5	9.0	7.4	8.0
	Trans	8.2	3.2	7.9	8.3	7.5	6.0	5.7	4.0
Red of area, %	Long	48.9	34.6	44.3	42.2	42.0	28.3	28.4	23.0
	Trans	17.1	6.8	27.2	23.1	31.5	16.5	12.4	9.4
Charpy V-notch impact properties, ft lb	Long R.T.	27	19	18	17	16	11	13	18
	Long—65F	17	17	14	13	14	7	9	15
	Trans R.T.	15	14	14	14	13	9	11	9
	Trans—65F	11	13	11	15	11	7	8	7
	Trans flash line R.T.	11	13	9	11	11	5	6	7
	Trans flash line—65F	9	9	6	11	8	5	4	7
Bend test[1] (load in lb; outside bend angle in degrees)	Long load	5570	8030	6600	7140	6150	6180	8330	10,200
	Long angle	180	70	147	167	145	180	58	35
	Trans load	5350	7660	6620	6840	6100	6630	7840	9650
	Trans angle	38	24	51	34	65	66	29	25
	Trans flash line load	4710	5000	6110	6390	5800	6000	6870	7750
	Trans flash line angle	15	5	18	15	25	13	11	10

NOTES:

Heat Treating Schedule (oil quench)

Steel	*Normalize*		*Austenitize*	
	Temp, F	*Time, hr*	*Temp, F*	*Time, hr*
4340	*1625*	*3*	*1575*	*4*
Modified 4340	*1625*	*4*	*1600*	*4*
HS-220	*1650*	*4*	*1600*	*4*
98B40	*1625*	*4*	*1600*	*4*
Tricent	*1700*	*4*	*1600*	*4*

All steels double tempered 3 to 4 hr at temperatures given in columns

[1]Load applied at center of 7/16 in. dia by 5 in. long specimen supported near end

forgings were approximately 12 in. in dia. After an isothermal anneal, they were bored to an inner diameter of about 9 in., cut to approximately 18 in. lengths and heat treated in this size. The program, carried out for the WADC by the Cleveland Pneumatic Tool Co. comprised tensile, notch tensile, impact and bend tests at room and subzero temperatures. Results of these tests indicate that strengths near 300,000 psi are obtainable without significant loss in ductility (Table 4). They show also the properties which can be expected in practice from these steels.

Owing to the circumstances under which the data were obtained, the results of this investigation probably afford the truest available indication of the suitability of these steels for highly stressed airframe parts. Data of this sort, obtained from test pieces extracted from full-sized regularly processed components, are rare because of the technical difficulties and major expense involved in obtaining such information. The carefully collected data of the WADC should, in the authors' opinion, therefore be given more weight than mechanical property values obtained from test stock which does not fairly represent the end product.

It should be emphasized that the use of steel at very high strength levels is not a matter to be undertaken lightly. High hardness values intensify certain hazards that are dormant or easily coped with at lower strength levels. These factors include sensitivity to hydrogen embrittlement in plating operations, to damage in grinding, to the effects of surface decarburation in heat treatment; and difficulty in welding, machining and other forming operations. Careful handling and meticulous inspection are required all along the line and particular effort must be made to design to minimize notch effects and other stress raisers.

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F. J. Ragland, Jr. and G. N. Barrett, Jr., "Evaluation of Forgings of 4340 Modified, and 4340, 98B40 Steels at High Strength Levels," WADC Technical Report 54-89, 1954.

F. A. Matter, F. J. Ragland, Jr. and G. N. Barrett, Jr., "Evaluation of Forgings of Inco and TM-2 Steels at High Strength Levels," WADC Technical Report 54-587, 1954.

George Sachs, "Survey of Low-Alloy Aircraft Steels Heat Treated to High Strength Levels," WADC Technical Report 53-254, part 4.

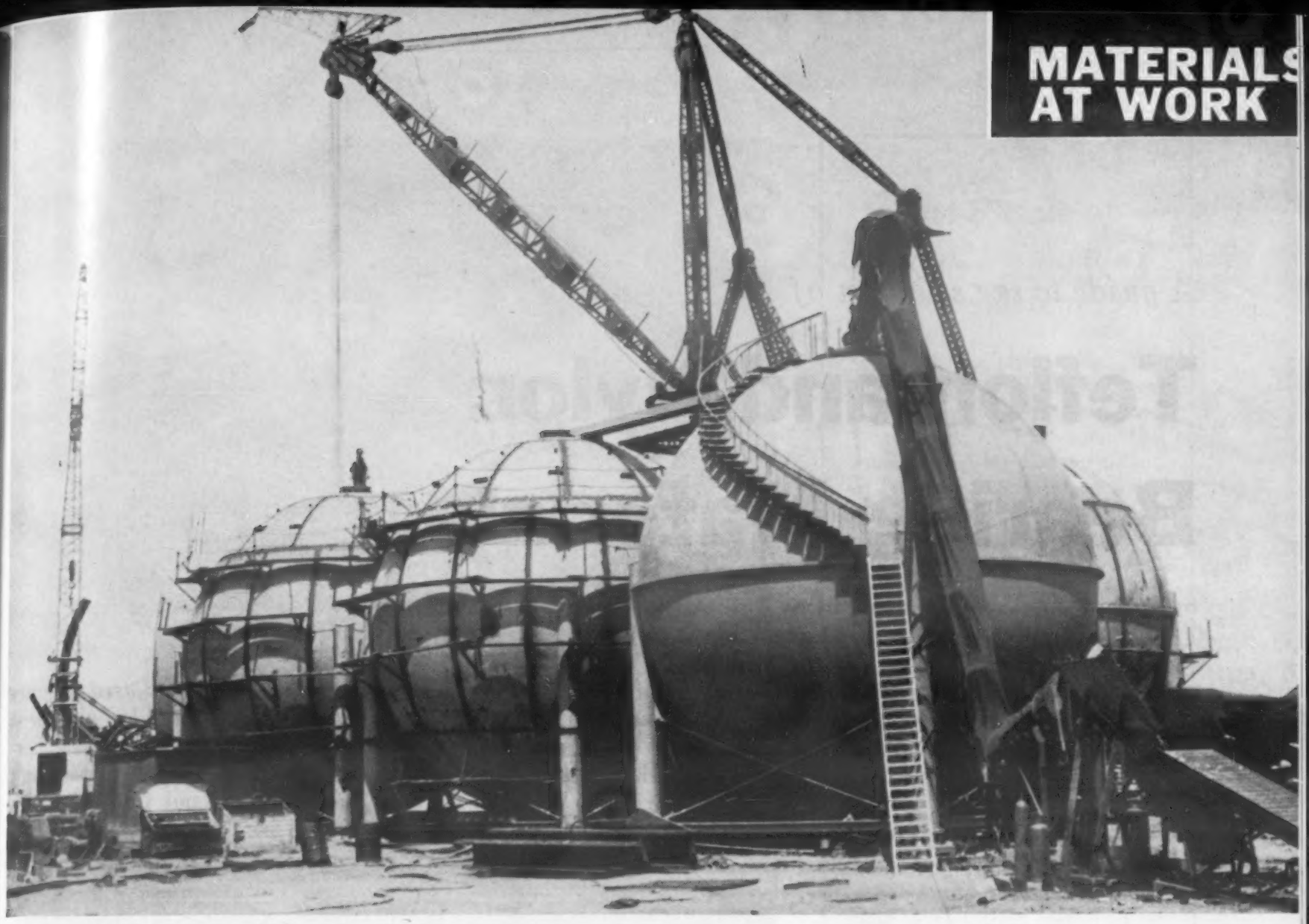
TABLE 5—PROPERTIES OF TRICENT STEEL[1]

5½ in. Diameter by ¾ in. Wall Flash Butt Welded Tubes Oil Quenched and Tempered At 400 F.

Property	Parent Metal	Across-the-Weld
Tensile Strength, psi	302,500	285,600
Notch Strength, psi	270,000	246,000
Elongation, %	9	3
Reduction in Area, %	18	7
Charpy V Impact, ft lb		
Room Temp	20	19
—65 F	18	14
Bend Test[2]		
Max Load, lb	9800	8900
Outside Bend Angle, deg	35	25

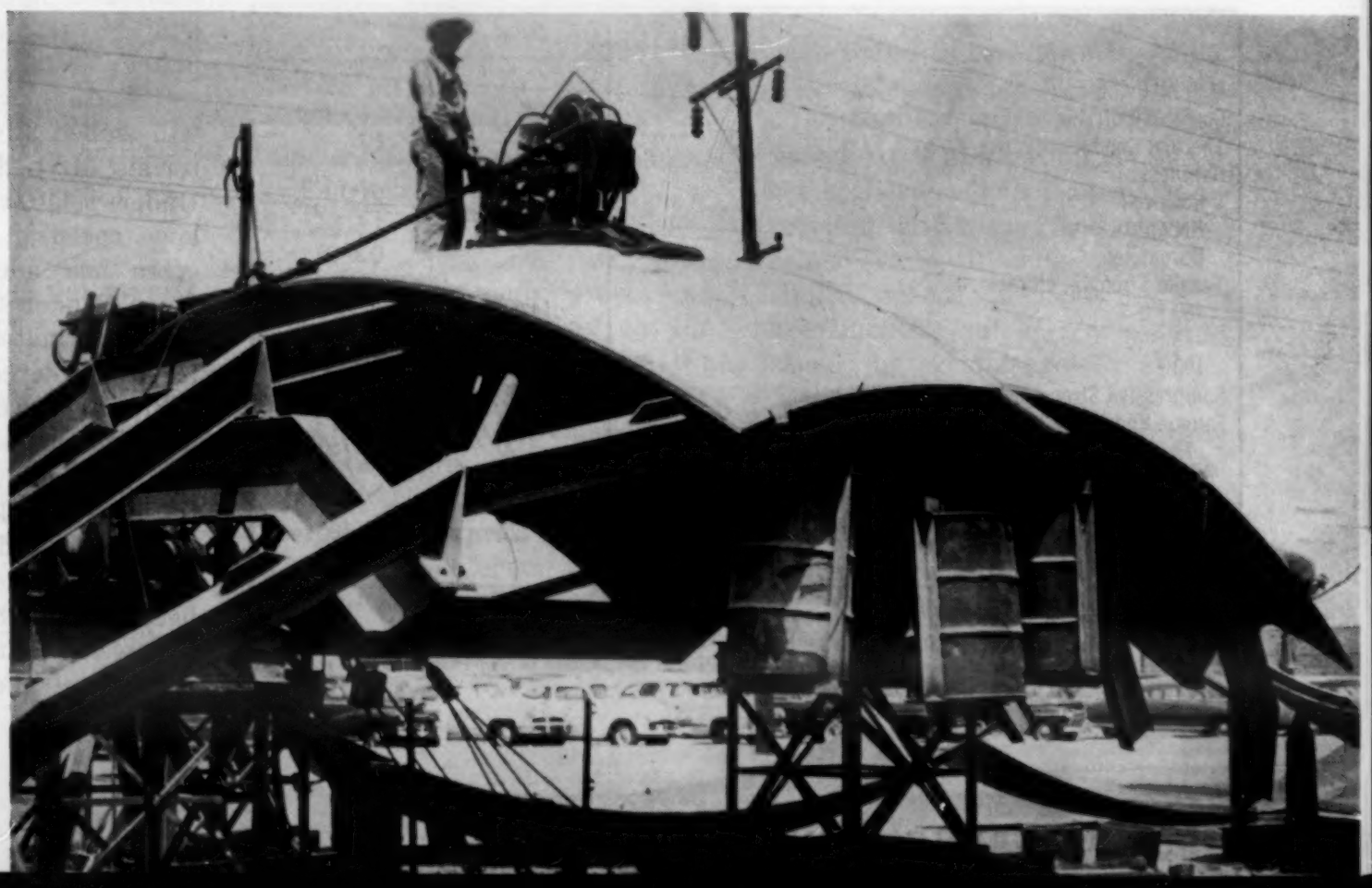
[1]Average of 3 to 6 determinations

[2]Load applied to the center of 7/16 in. dia by 5 in. long rounds supported near ends



Welded steel holds compressed air

Each of these all-welded steel tanks will hold 291,000 gallons of air, compressed to 132 psi. The air will be used in a supersonic wind tunnel being constructed for North American Aviation by Pittsburgh-Des Moines Steel Co. The dished top and bottom sections, 1-3/16 in. thick, were mounted on a rotating jig and submerged arc-welded by an automatic head, which rode on a tractor attached to assembly. The welding head, from Lincoln Electric Co., produced a speed of about 8/10 of a ft per min.



A guide to the selection of

Teflon and Nylon Bearing Materials

by A. J. Cheney, W. B. Happoldt, K. G. Swayne, *E. I. du Pont de Nemours and Co., Inc.*

■ The unique frictional properties of nylon, a polyamide resin, and Teflon, a polytetrafluoroethylene resin, have been one of the major reasons for their extensive use in industrial and consumer bearing applications. However, as yet there has been no successful correlation of operational and test data which clearly indicates when to use which material for a specific application. Recent data on nylon and Teflon used in bearing applications under a variety of service conditions should permit greater accuracy in selecting materials, and put future bearing design on a firmer basis.

Teflon

Used dry
High temperature strength
Excellent corrosion resistance

General properties

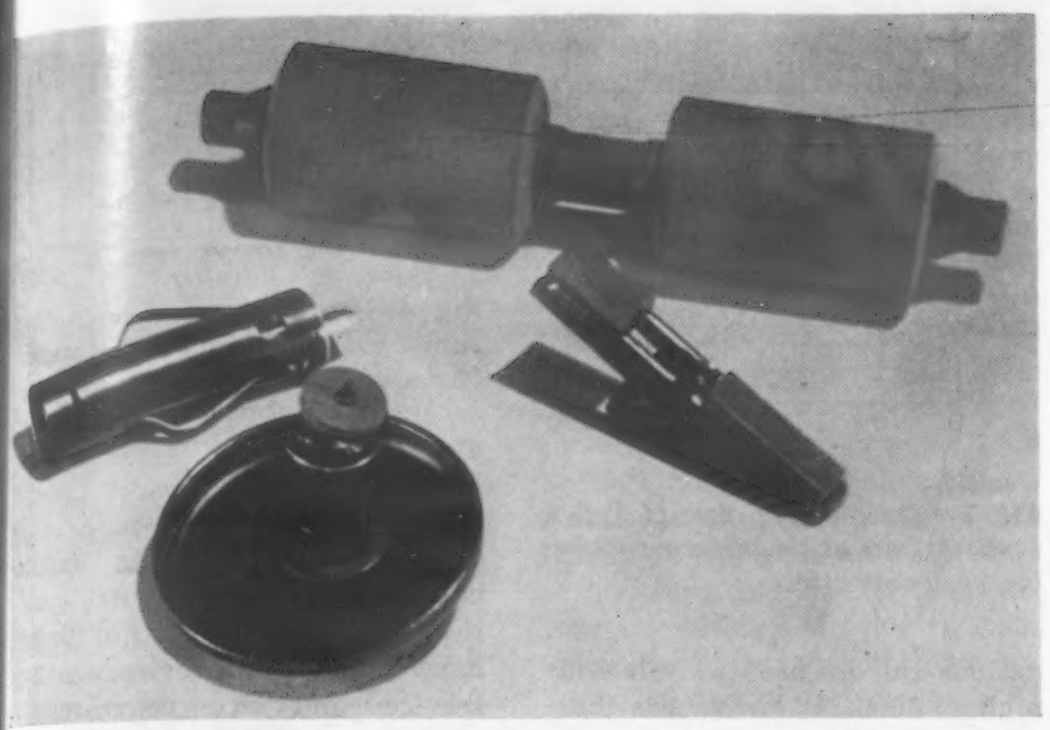
The most important characteristic of Teflon for bearing applications is its low coefficient of friction, which can be as low as 0.04 or less. This can be compared with values of 0.09 to 0.12 for such familiar dry lubricants as molybdenum disulfide and graphite. As shown in Table 1, Teflon's compressive and tensile strengths are not as great as nylon. However, it has excellent thermal stability and can be used continuously at temperatures up to about 500 F and intermittently up to 620 F.

TABLE 1—TYPICAL PROPERTIES OF NYLON AND TEFLON[a]

	Nylon	Teflon
Melting Point, F	485	620
Coefficient of Thermal Expansion, in./in./F	5.5×10^{-5}	5.6×10^{-5} [b]
Thermal Conductivity, Btu/hr/sq ft/F/in.	1.7	1.7
Hardness:		
Rockwell	R118	R25
Knoop	6.5	2.8
Durometer	—	D50-65
Tensile Strength, ultimate, psi		
60 F	14,000	5000
73 F	9300	3000
190 F	6000	1500
Compressive Strength, 1% deformation, psi	2500	600
Fatigue Endurance Limit, psi		
73 F	3000	760
212 F	2000	—
Upper service temperature limit, F,		
Continuous	170[c]	500
Intermittent	—	670

[a] Values given are for Zytel 101 (FM-10001) conditioned to average air exposure.
[b] Transition point at 70F results in linear increase of 0.004 in. per in.
[c] For continuous use at temperatures above 170F a heat stabilized composition is recommended which retains properties for over 50,000 hr at 250F, and for 2000 hr at 300F.

Teflon is soft and tough and will embed any hard foreign materials often found in bearings. Under relatively light loads and low speeds, unmodified Teflon often has adequate wear resistance. Under severe conditions reinforcing materials such as graphite or powdered glass will provide additional wear resistance. Teflon and glass combinations have shown wear rates 100 times better than those of unfilled Teflon. Though reinforced Teflon has a somewhat higher coefficient of friction and better resistance to deformation and wear than unfilled material, in general the addition of rein-



Teflon's low coefficient *of friction makes it suitable for use in these parts of a textile machine. It is used in the front roll shown at top (small diameter segments are of Teflon), two areas of the saddle (center right) for the front roll, and in the washer at the end of the bobbin holder at bottom.*

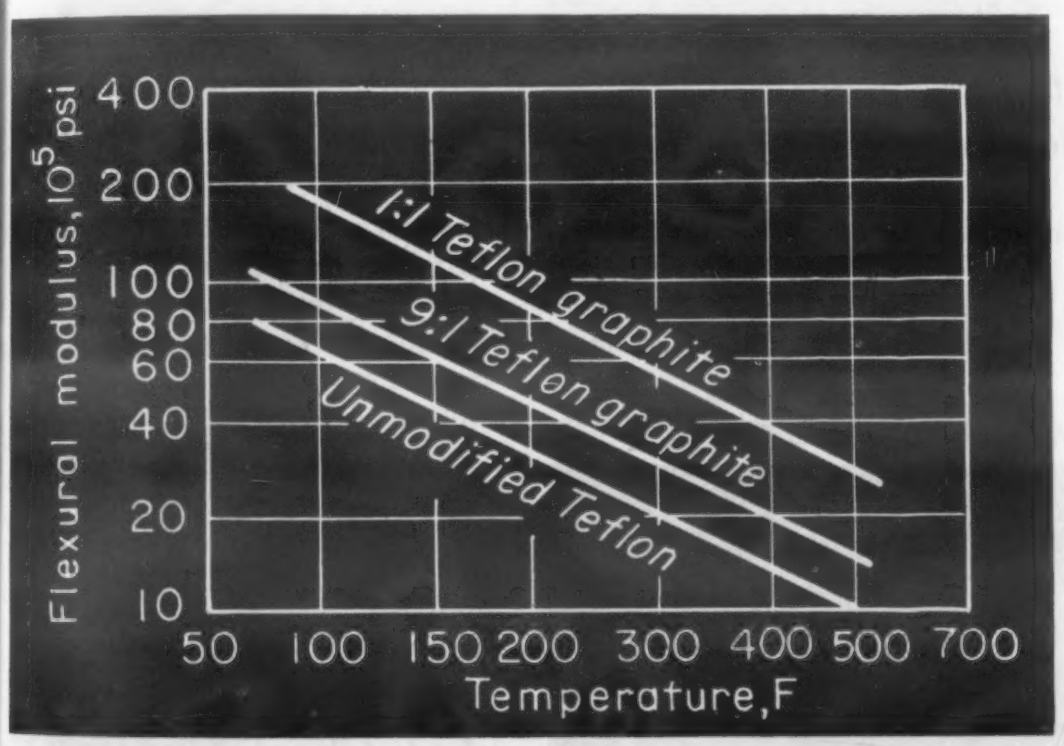


***Fig 1**—Note the effect of filler ratio and temperature on flexural modulus of elasticity of Teflon. Ratios of graphite filled Teflon are by weight.*

forcing materials does not greatly alter physical properties of the material.

Short time deformation properties of unmodified and modified Teflon, as measured by flexural modulus of elasticity are shown in Fig 1. Modulus is a function of temperature and amount of reinforcing material used. If the modulus of any given composition is known at one temperature, the value at other temperatures can be estimated accurately from the given curves in Fig 1 since the curves are parallel. As with many materials, moduli of elasticity of Teflon in flexure, tension and compression are essentially the same. Therefore, compressive stress to produce 1% deformation for the modified compositions increases in the same proportion as the modulus.

The Puzzle of Teflon's Constant Coefficient

A puzzling phenomenon encountered by workers studying tetrafluorethylene's frictional characteristics has been the constance of its 0.04 coefficient of friction. It is retained when the contact is between Teflon and Teflon or between Teflon and metal surfaces. Several years ago, workers at the Naval Research Lab verified a previous supposition, that is, that Teflon when rubbed against a metallic surface rapidly deposits a monomolecular layer of tetrafluoroethylene on that surface. The end result is that when Teflon bearings are used against non-Teflon surfaces, conditions after preliminary "run-in" are essentially Teflon against Teflon with a resulting coefficient of friction of 0.04.

Friction in service

Though there has been a tendency to assign one coefficient of friction value to a plastics material, sliding speed has been found to affect friction characteristics. A major portion of the increase in coefficient with rubbing speed has been found to be a permanent unreversible change. That is, once a Teflon surface has been subjected to a high rubbing speed, the higher coefficient normally associated with higher speeds is obtained even at subsequent low sliding speeds. Reasons for this are unclear, but it seems to be caused by crystal growth.

Frictional coefficient of Teflon is constant over a temperature range of 80 to 620 F. Once the melting point is exceeded friction doubles. Thus, high frictional values obtained in some tests could be due to the fact that surface temperatures exceeded the melting point of the resin.

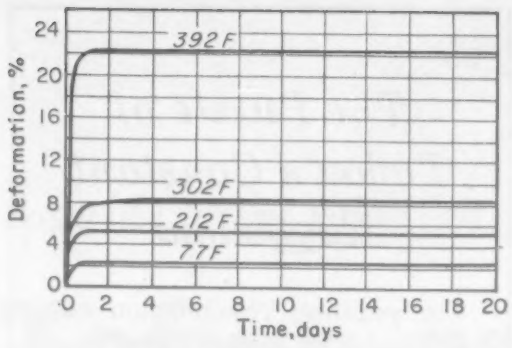


***Fig 2**—Effect of long-time compression at 1000 psi on solid Teflon at various temperatures.*

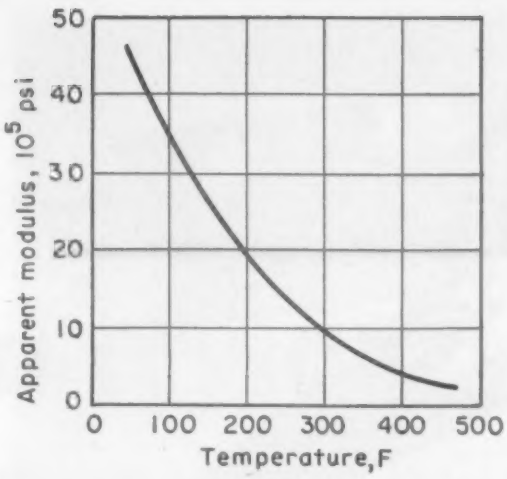


***Fig 3**—Creep or cold flow of Teflon is shown here at the apparent modulus vs temperature.*

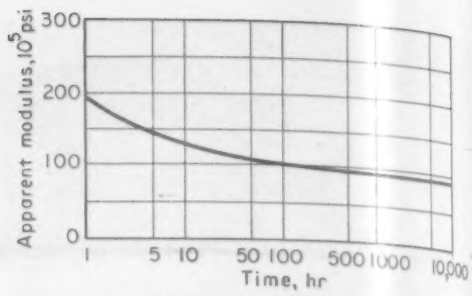


***Fig 4**—The extremely low friction values obtainable with Teflon cannot be improved by lubricant additives such as molybdenum disulfide or graphite.*

Load carrying capacity of Teflon bearings can be estimated from the PV ratio, where P is pressure in psi and V is velocity in feet per min. Unmodified Teflon over a wide range of loads and speeds should be used at PV values below 1000, while filled combinations can be used at values as high as 5000. At low speeds these values can be higher.

Most commercial Teflon bearings in use today are simple sleeves or thrust washers. Saddle bearings are also used. Ball bearings with alternate balls of Teflon have proved to provide unusual service and are commercially available. The latest development is porous metal bearings impregnated with Teflon (M&M, Sept '55).

Nylon

Lubrication preferred
High strength at room temperature
Good corrosion resistance

General properties

At room temperature, nylon is harder, stronger and more resistant to abrasion and deformation than Teflon. However, at elevated temperatures the reverse is true. The nylon resin discussed here is Zytel 101 (FM-10001) which has the highest melting point and is the stiffest of DuPont's commercial nylons.

Coefficient of friction values depend to a large extent on type of test and conditions under which they are made; therefore, comparison between sources is difficult. For example, in a modified Bowden-Leben type stick-slip machine, at low surface speeds of about ¼ in. per min, friction coefficients of 0.46 static and 0.37 kinetic were obtained for nylon-on-nylon with no lubricant. Milz and Sargent report a range of values taken with a crossed-cylinder apparatus, at applied loads of 1 to 5 lb and sliding speeds of 8 to 367 ft per min. With no lubricant values ranged from 0.15 to 0.33; with water, values ranged from 0.14 to 0.18; and in oil, values ranged from 0.09 to 0.14. Completely dry bearings can be used for limited loads and speeds. Addition of water improves performance slightly, and a lubricating oil improves it greatly.

***Typical of the applications** for which nylon and Teflon are well suited are these nylon bearings.*

Moisture absorption

Nylon absorbs moisture from its environment until an equilibrium condition is reached. Since best quality moldings are obtained

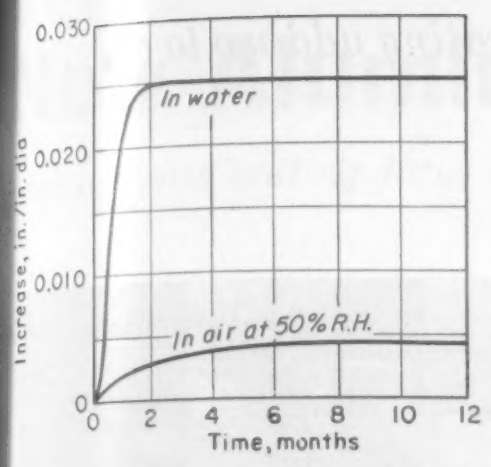


Fig 5—*Effect of moisture on i.d. of nylon bearing with 1-in. i.d., 0.100 wall thickness.*

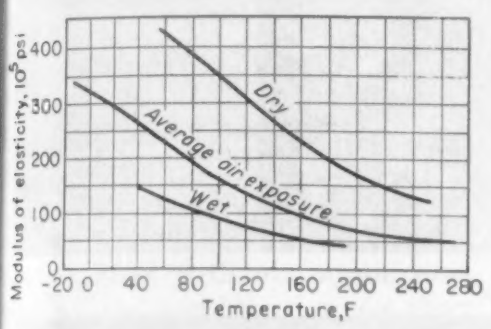


Fig 6—*Effect of moisture and temperature on modulus of elasticity of nylon (Zytel 101).*

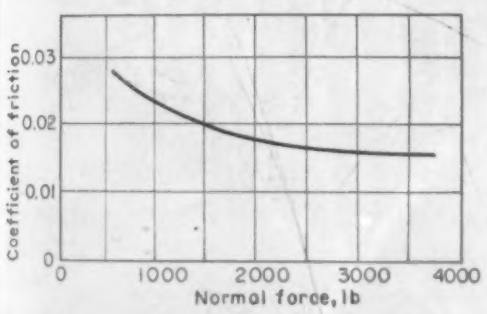


Fig 7—*Creep or cold flow is shown here as the apparent modulus for nylon after average air exposure.*

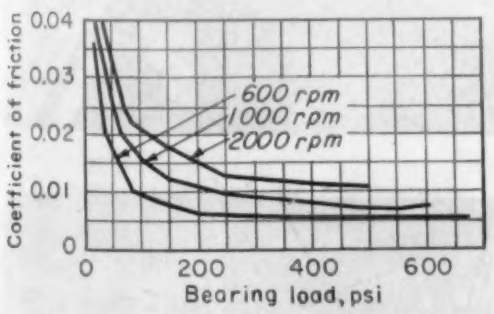


Fig 8—*Curves show effect of bearing loads and speed of revolution on lubricated nylon bearing with a 0.049-in. wall and a clearance of 0.0025 in.*

with molding powder containing less than 0.3% water, as-molded material will absorb water. Moisture content of nylon parts affects dimensions, strength and stiffness. As shown in Fig 5, once initial change in dimension due to moisture absorption has occurred, further change with normal variations in environmental conditions is small. Of course, bearings must be so sized that dimensions will be correct at equilibrium conditions expected. After molding, they must be moisture conditioned to or near the equilibrium condition.

Strength and impact resistance are also dependent upon moisture content. Parts conditioned for average air exposure have impact resistance of approximately twice that of as-molded material. Effects of moisture content and temperature on stiffness or deformation under compressive load (which can be calculated from modulus of elasticity) can be seen in Fig 6. For most work, values can be taken safely from the curve for average air exposure, which represents actual values for parts moisture conditioned to 2.5% water. Compressive modulus of elasticity is independent of stress up to approximately 3000 psi. Thus, if a bearing with a 0.100 in. wall is under a compressive load of 400 psi, initial unit deformation at room temperature would be 400 divided by the modulus, 200,000 or 0.002 in. per in. Since the wall is only 1/10 in. thick, total deformation is 0.0002 in.

Creep or cold flow

Another important consideration in designing nylon bearings is creep or cold flow, i.e., deformation with time under load. For example, parts at room temperature and average moisture content have been found to initially deform 0.009 in. per in. at a compressive stress of 1800 psi, and 0.002 in. per in. at a compressive stress of 450 psi. With time, if the load is continuously applied, deformation will continue until it is about twice the initial change in 200 hr. After this time, though load is still applied, little deformation takes place.

A simple yet accurate method of determining creep or cold flow is to consider the continued deformation as a change in compressive modulus of elasticity with time, called apparent modulus. Thus, in Fig 6, initial modulus is 200,000 psi at room temperature and after average air exposure. Yet Fig 8 showing apparent modulus indicates that in approximately 200 hr nylon has deformed as though the modulus were ½ of this or 100,000 psi. For other environmental conditions, apparent modulus can be estimated by starting with the appropriate initial modulus and drawing a curve parallel to the one shown in Fig 8.

An example indicates the practical application of the curves. Suppose a bearing with an 0.060 in. wall has a maximum unit loading of 400 psi and is to operate in air at a maximum temperature of 150 F. What deformation would be expected if the bearing were loaded for 1000 hr or longer? Assuming average moisture content, from Fig 6, modulus at 150 F is found to be 100,000 psi. Estimating from a parallel curve drawn in Fig 8, apparent modulus beyond 1000 hr would be 45,000 psi. Then dividing 400 by 45,000 gives a deformation value of 0.009 in. per in. The deformation of 0.009 times wall thickness of 0.060 equals 0.0005 in. maximum deformation.

Operating conditions for nylon bearings can be estimated from PV values given in Table 2. Since heat seems to be primary cause of failure, this value can be used for design over a wide range of loads and speeds. While bearings can seize and fail if temperatures become excessive, properly dimensioned bearings can be run with a temperature rise of 100 F or more if ultimately stable conditions are reached. Undoubtedly higher temperatures result in increased wear rates, though little data has been obtained.

TABLE 2
SAFE PV VALUES FOR NYLON BEARINGS

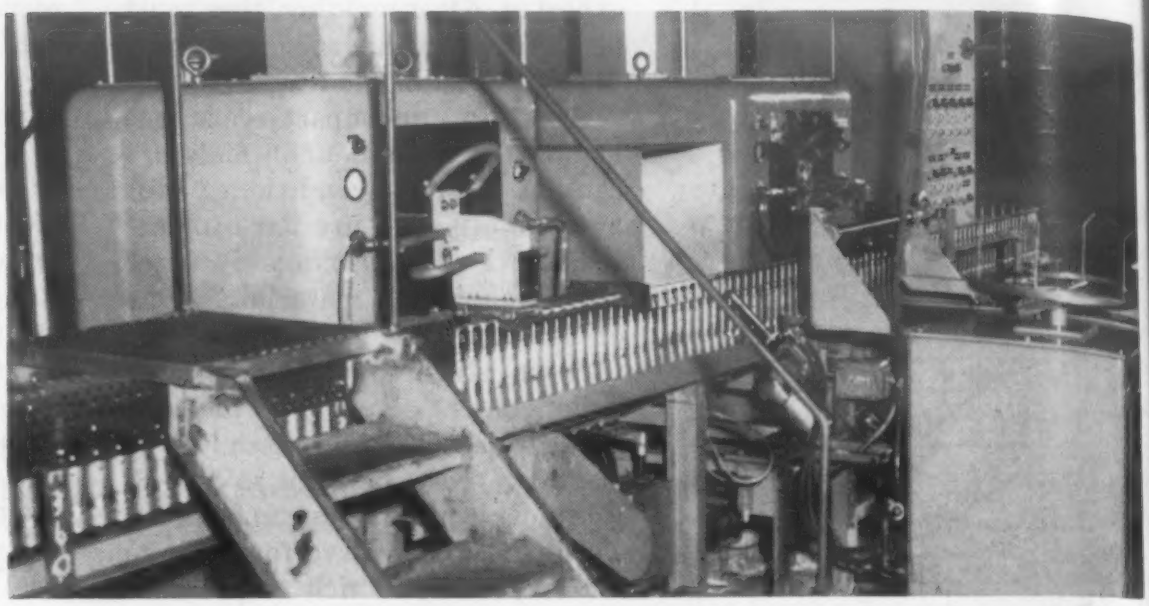
Condition	Continuous Operation	Intermittent[1] Operation
Dry	500-1000	3000
Water	1000-1500	4000
Oil Initially	2000	8000

[1] *Where shaft is in motion approximately ⅓ of time and continuous operation is less than 15 min per cycle.*

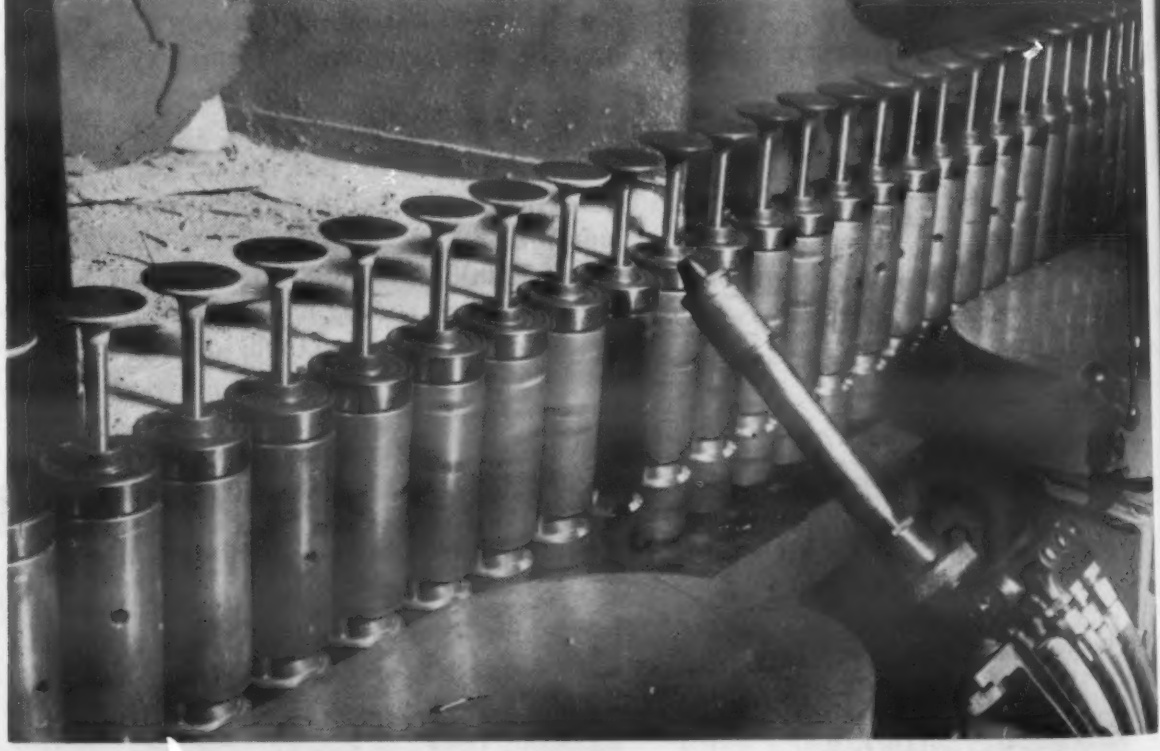
This article is based on a paper delivered before the Society of Automotive Engineers' Annual Meeting, Jan, 1956.

Continuous wire spraying plus induction heating add up to a . . .

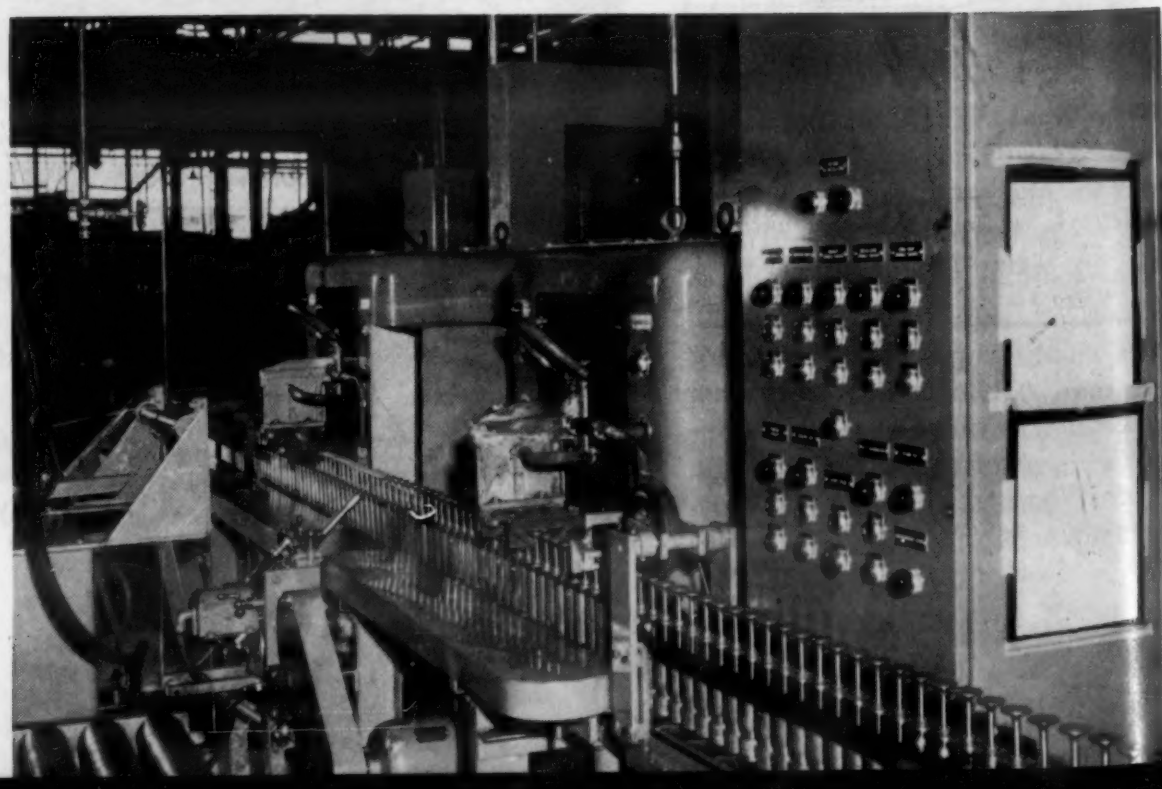
1. Valves are preheated *to about 450 F by a 7½-in. induction coil. Carried by a continuous conveyor, the valves are held vertical by cylindrical fixtures which not only position the valves but also protect the ground surface of the valve stems.*



2. Valve seat faces are sprayed *with aluminum. From the preheat coil, the valves pass before a conventional oxyacetylene gun fed with 1100 aluminum wire. Throughout the process the conveyor moves at 5½ ft per min and fixtures rotate at 550 rpm.*



3. Aluminum coating is diffused *into the steel by heating the coated valves to about 1450 F in a second, 21-in. induction coil. Both coils operate at 9600 cps. The aluminized valves then cool in air. Capacity of the unit is about 2000 valves per hour.*



New Aluminized Coating

Pontiac coats seating faces to increase engine valve life

by **Kenneth Rose,** *Midwestern Editor, Materials & Methods*

Iron-aluminum alloys have good resistance to oxidation at elevated temperatures. However, they are hard and brittle and consequently difficult to fabricate. As a result they have been used most successfully so far in the form of a relatively thin coating or layer on steel.

A thin iron-aluminum alloy coating is produced essentially by coating steel with aluminum and heating the combination so that the aluminum diffuses into the iron surface. Such a result can be achieved by several different techniques. One is to fabricate the part from aluminum-clad steel, the alloy layer being formed during service at elevated temperatures, as in electronic tube anode plates. Another method is to use steel sheet or strip that has been coated with aluminum by hot dipping (Armco's Aluminized Steel). The best known method for producing such a coating on fabricated parts is the Aldip process patented several years ago by General Motors Corp. In this process parts are dipped in molten aluminum that is protected from the atmosphere by a molten salt bath.

The newest technique for aluminizing fabricated parts is the one now being used by the Pontiac Motor Div. of General Motors for the production of automotive engine valves. Here the aluminum coating is applied by spraying ("metallizing") instead of hot dipping. Spraying makes it possible to restrict the coating to the valve faces. Before spraying, the valves are preheated to about 450 F. After spraying, the valves are heated to about 1450 F to diffuse the aluminum into the steel surface. Induction heating is used in both cases. The entire process is carried out at high speeds on completely automatic equipment specially designed and built for this particular application.

All finishing operations—including grinding the valve stem and grinding and lapping the seating surfaces—are done prior to aluminizing. Oil and grease are removed in a vapor degreaser.

After diffusion, the iron-aluminum alloy layer ranges from 0.8 to 1.5 mils in thickness, and the outer layer of aluminum remaining has a maximum thickness of 0.5 mil. Although the coating may show surface crazing, it does not crack. In addition to improving oxidation resistance of the valve steels, the alloy layer materially reduces the amount of deposits that adhere to the valve seat faces during engine operation.

The improvement in oxidation resistance, compared to uncoated valves, is reflected in data on the performance of engine valves in current model automobiles. In cars subjected to accelerated performance tests, no aluminized valves failed in cars operated more than 50,000 miles, whereas failures in uncoated valves began at about 25,000 miles. In an earlier model engine, failures in uncoated intake valves began at about 2700 miles, and failures in uncoated exhaust valves began at about 3100 miles.

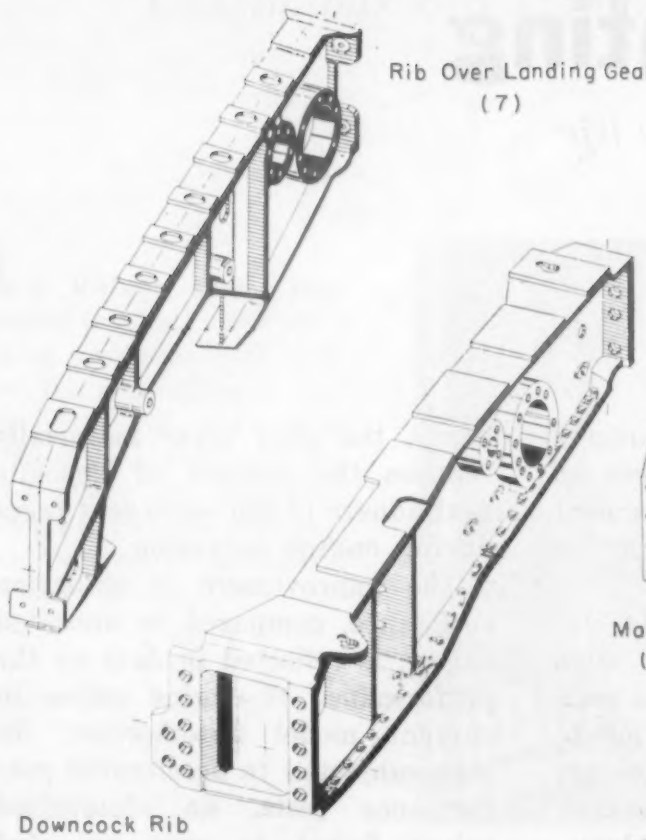
VALVE STEEL COMPOSITION (%)

	Intake Valves	Exhaust Valves
Carbon	0.35-0.45	0.35-0.50
Manganese	0.25-0.40	1.00 max
Silicon	3.60-4.20	1.00 max
Chromium	1.85-2.50	23.00-24.00
Nickel	—	4.50-5.00
Molybdenum	—	2.50-3,00

RESULTS OF CONTROLLED ACCELERATED CAR PERFORMANCE TESTS[a]

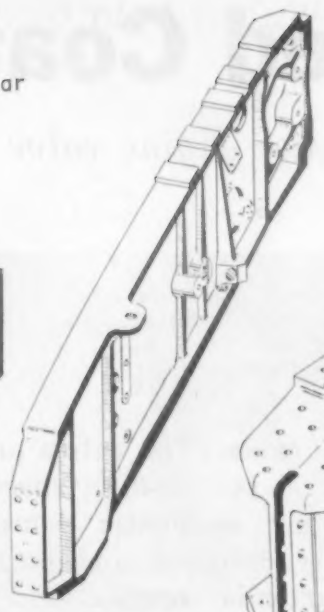
Uncoated Valves			Aluminized Valves[b]		
Miles (approx)	No. intake valves failed	No. exhaust valves failed	Miles (approx)	No. intake valves failed	No. exhaust valves failed
25,100	1	0			
46,800	0	1			
53,700	2	0			
56,100	0	0	54,500	0	0
			67,200	0	0
			78,200	0	0
			83,200	0	0
			85,900	0	0

[a] *Current model engines*
[b] *All aluminized valves still running*

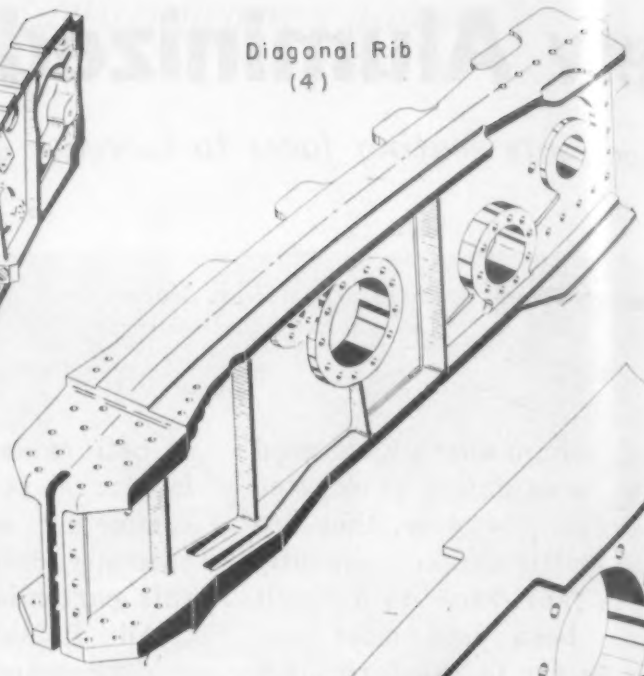


Rib Over Landing Gear
(7)

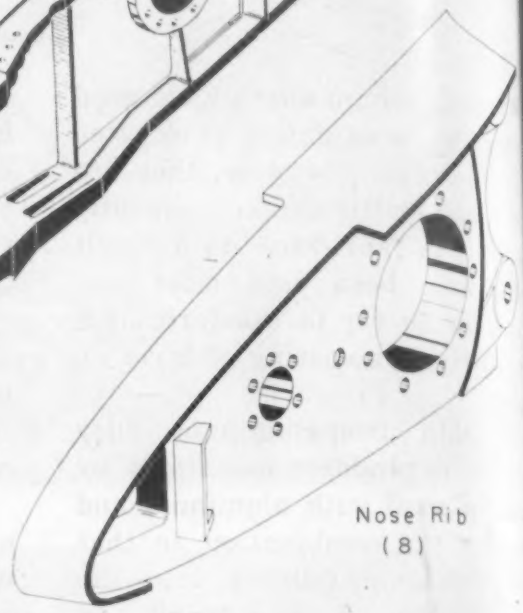
Downcock Rib
(5)



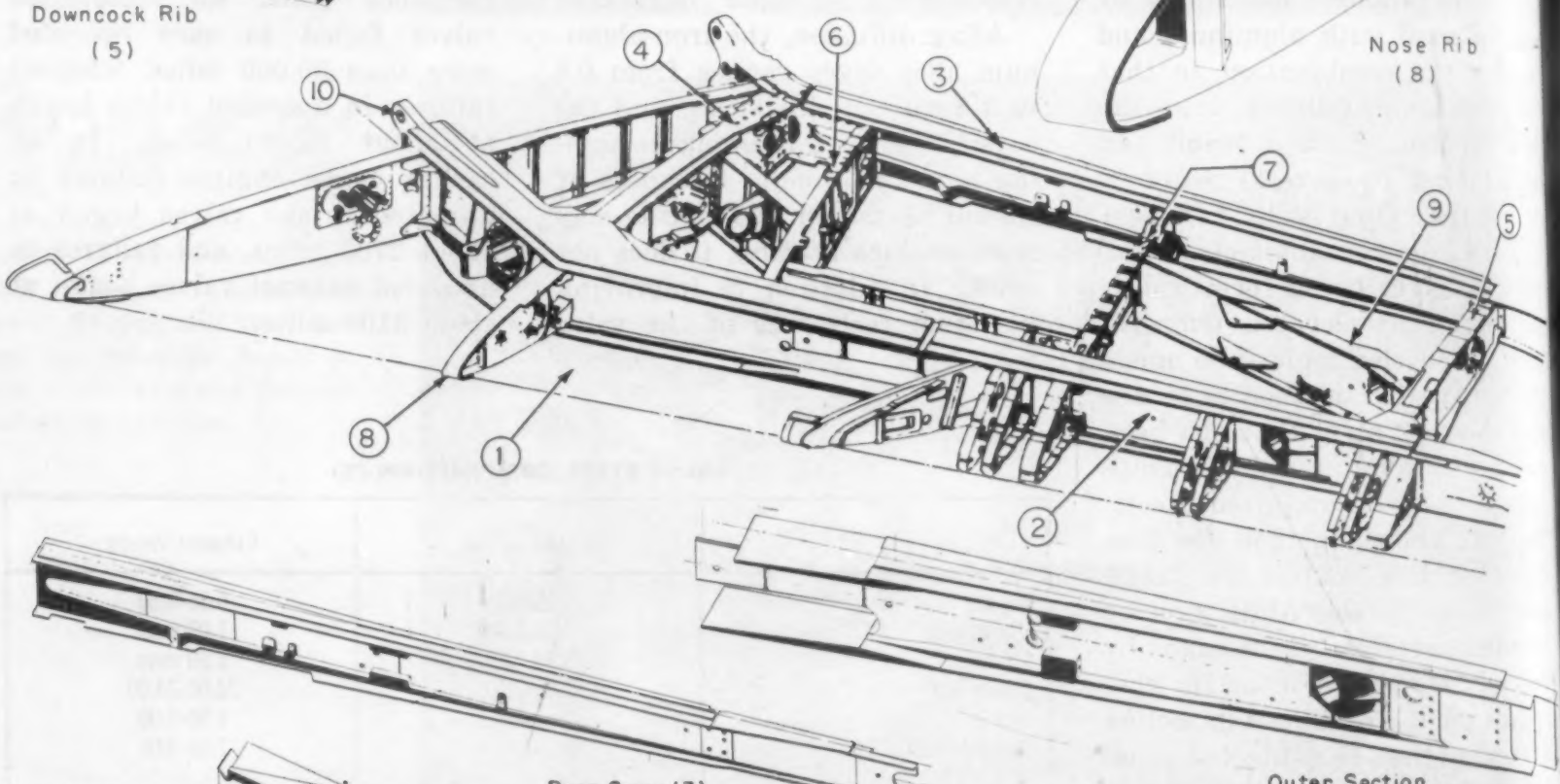
Main Rib
(6)



Diagonal Rib
(4)

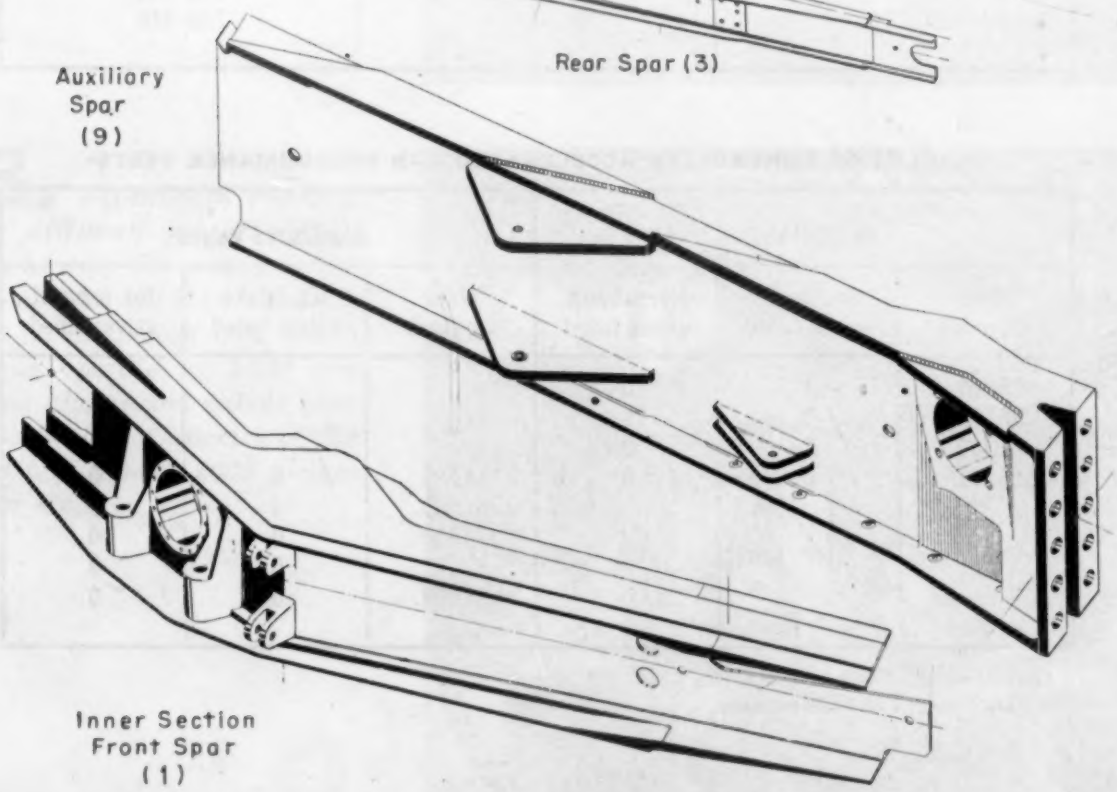


Nose Rib
(8)



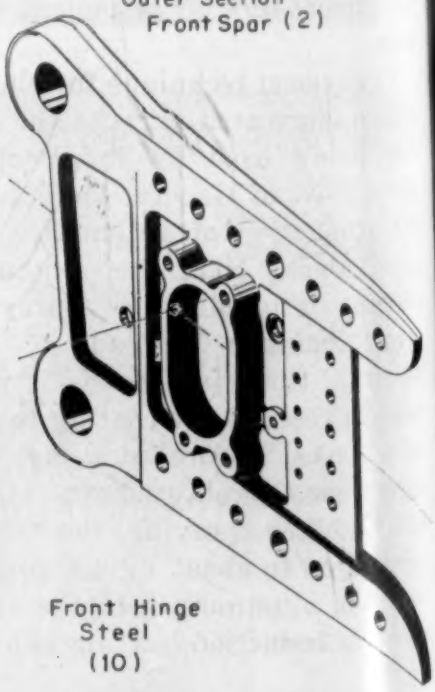
Rear Spar (3)

Auxiliary
Spar
(9)



Inner Section
Front Spar
(1)

Outer Section
Front Spar (2)



Front Hinge
Steel
(10)

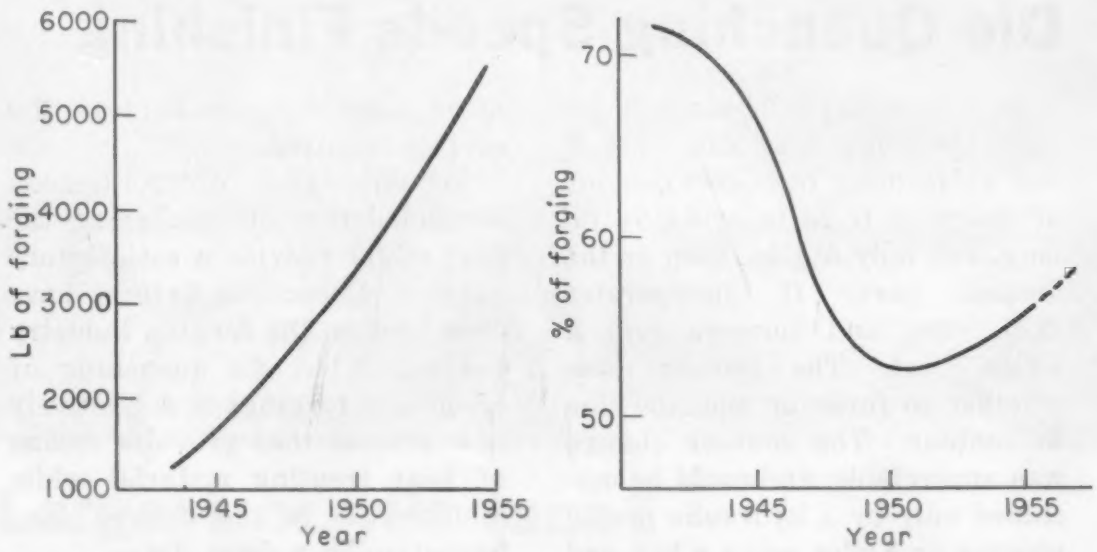
← These Forgings in Aircraft

Save Weight Improve Design

by **C. R. Kramer,** *Development Engineer,* **and A. Kastelowitz,**
Chief Manufacturing Engineer, Republic Aviation Corp.

Republic's experience with forgings for aircraft verifies that not only do forgings save time and weight, but their strength and compactness are an asset to aircraft design. In the F84F, for example, the total number of forgings used was 295 or 426 pieces per airplane. The total weight of forgings was 3328 lb or 35% of the airframe weight. As machined, this weight was reduced to 1712 lb per airplane or 19% of the airframe weight.

A later Republic design uses 229 forgings of both steel and aluminum alloy, or a total of 436 pieces per airplane. These forgings weigh better than 5500 lb per airplane with the final machined pieces weighing less than 3200 lb. From the F84F to this design, the number of forgings did not increase appreciably but the weight almost doubled, an indication that the size of forgings is increasing.



Trend of Forgings Is Up

Curve A (left) shows trend of forging at Republic. Increases in the use of forgings are due to the fact that: 1) forgings definitely save weight, and 2) the final cost of a piece machined from a forging will be from 20 to 25% cheaper than an equivalent part assembled from many pieces.

Curve B shows the percentage of material remaining in the forged part after machining. Ten years ago when smaller forgings more compatible with the size of presses available were used, 70% of the forgings was retained after machining. Five years ago with the advent of large complicated forgings the size of the press and the state of the art made it necessary to machine away as much as 50% of the forging. However, with the new methods becoming available, the trend is toward less and less machining. Current figure at Republic is 57% with the former figure of 70% a definite possibility in the near future.

F84F Wing Forgings

The trend toward increased use of forgings is illustrated in the wing assembly of the F84F aircraft. After forging, the inner or root section (1) of the spar was machined for hinge fitting, pylon attachment fittings, gas tank interconnect, and diagonal rib attachment. The outer section forging (2) was machined for the splice, rib attachments and landing gear trunnion. The rear spar (3) was forged in one piece. It was only a short step from here to include six major, highly loaded ribs, the auxiliary spar used to support the landing gear trunnion and the wing hinges (4 to 9). The wing hinges, (10) however, were forged of steel while the remaining were of alu-

Fig 1—*Completed front spar forging.*

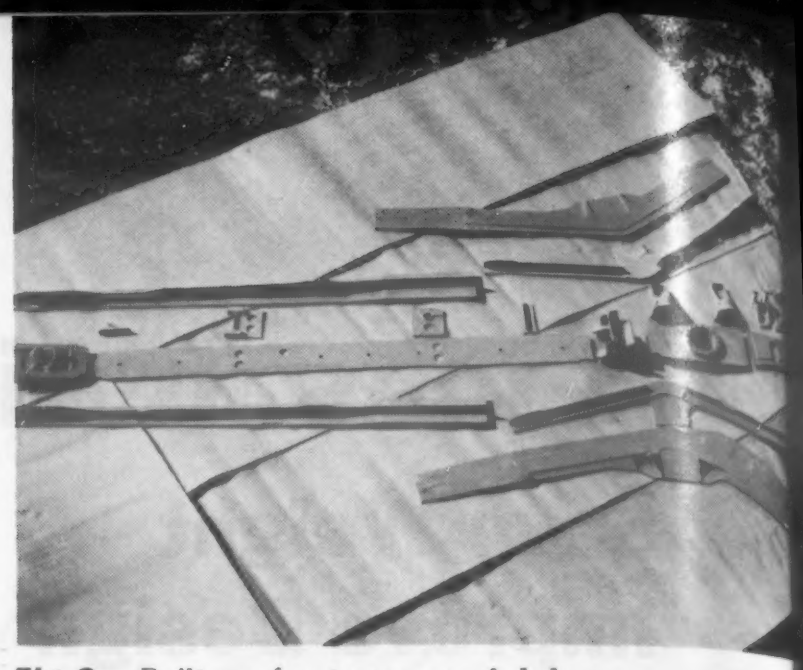


Fig 2—*Built up front spar—exploded.*

minum alloy. Since the time these pieces were forged, equipment and techniques have become available that would allow improvement with smaller draft angles, less weight, and less machining.

To prepare for any contingency, built up spars were designed to be interchangeable with forged spars. Comparison between a front spar forging (Fig 1) and a built up spar (Fig 2) showed the built up spar to be 74 lb heavier per airplane. A built up rear spar was 10 lb heavier per airplane.

Die Quenching Speeds Finishing

In a later Republic aircraft design, the wing spar cap (Fig 3 and 4) forming the outer contour of the wing is 26 in. wide, 76 in. long, and only 5½ in. deep at the deepest part. It incorporates skin, ribs, and formers into a single part. The problem was whether to forge or machine this to contour. The contour change was appreciable, and could be machined only by a hydraulic profile planner or Keller using a ball end mill. Both methods are very slow, involving considerable finishing after machining to achieve the surface required.

Republic and Wyman-Gordon concluded that die quenching the part might provide a satisfactory answer. Quenching fixtures have been used in the forging industry for years but die quenching of aluminum forgings is a relatively new process that provides means of heat treating material while confining it to the desired configuration in a form die.

The final parts formed by this process were within 1/32 in. of the required contour. It is believed that further improvement can be achieved by additional control of the quenching procedure. However, until this can be checked, the parts are presently shipped in the "W" condition, and hand straightened as required at Republic and aged.

This article was adapted from a paper presented before the annual meeting of the Society of Automotive Engineers, January 1956.

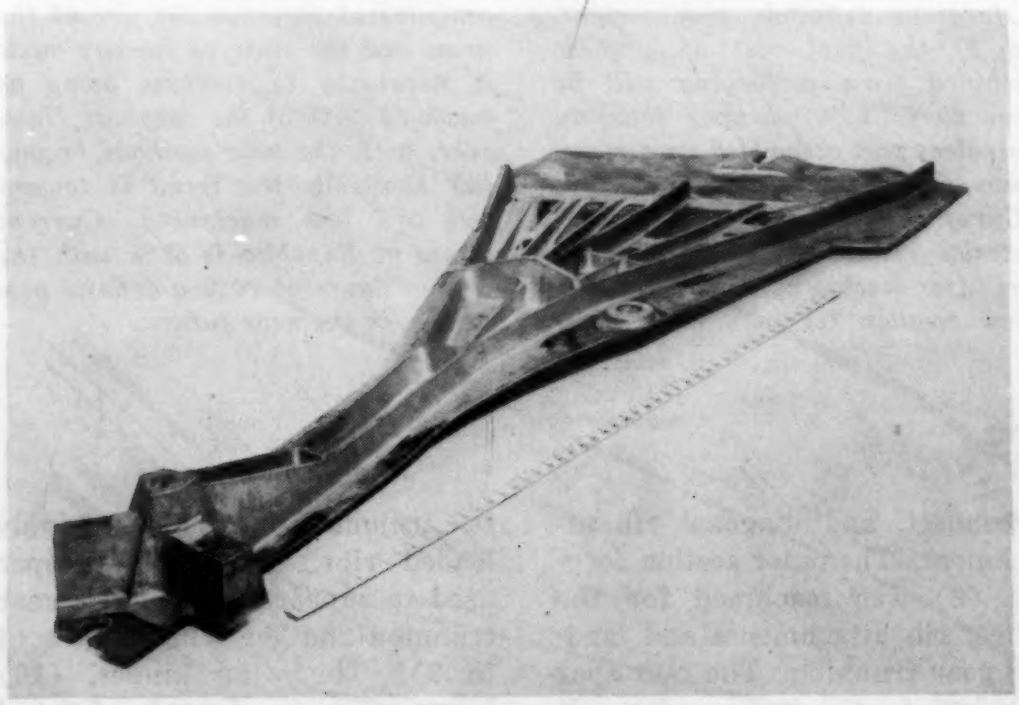
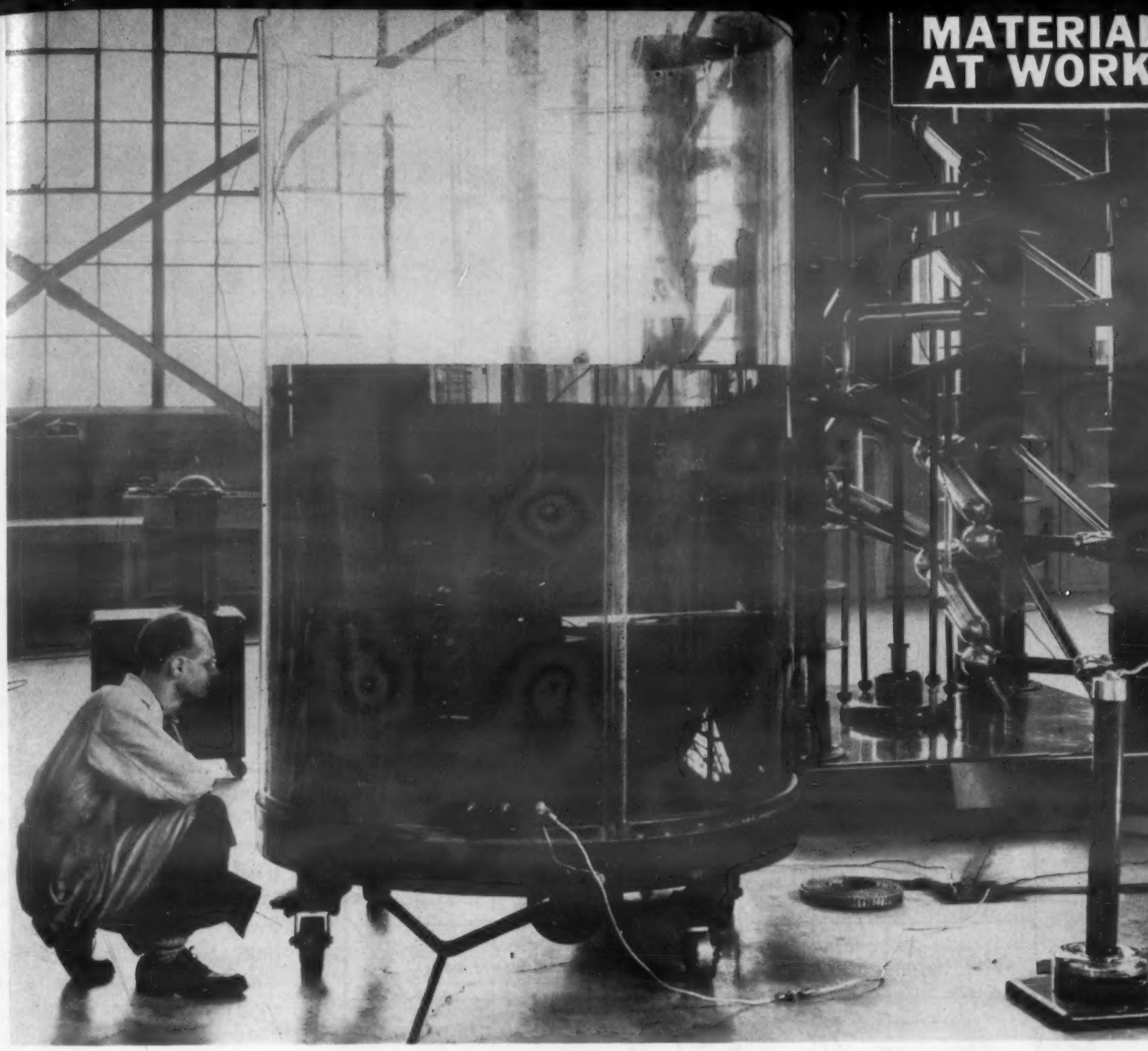


Fig 3—*Spar cap—aluminum alloy.*

Fig 4—*Contour of spar cap.*



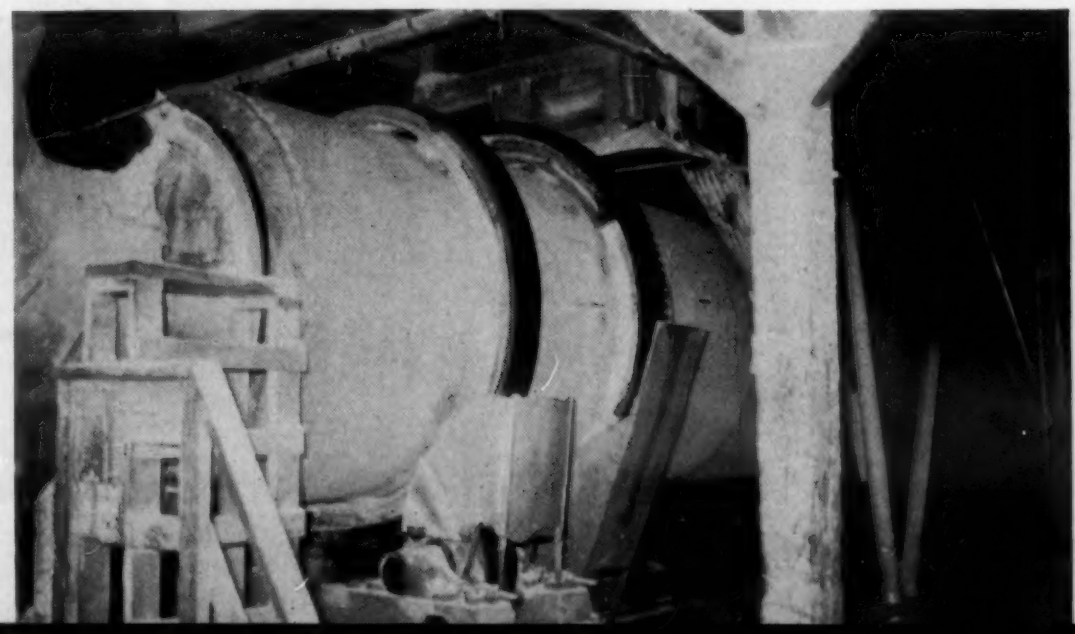
Largest acrylic tank?

This Plexiglas test tank is being used by Packard Electric Co., Ltd., to subject prototype transformer coils to breakdown tests. Previously used steel tanks had limited visibility making it difficult to detect exactly where and how breakdown was occurring. Also, it was difficult to observe failure the moment it began.

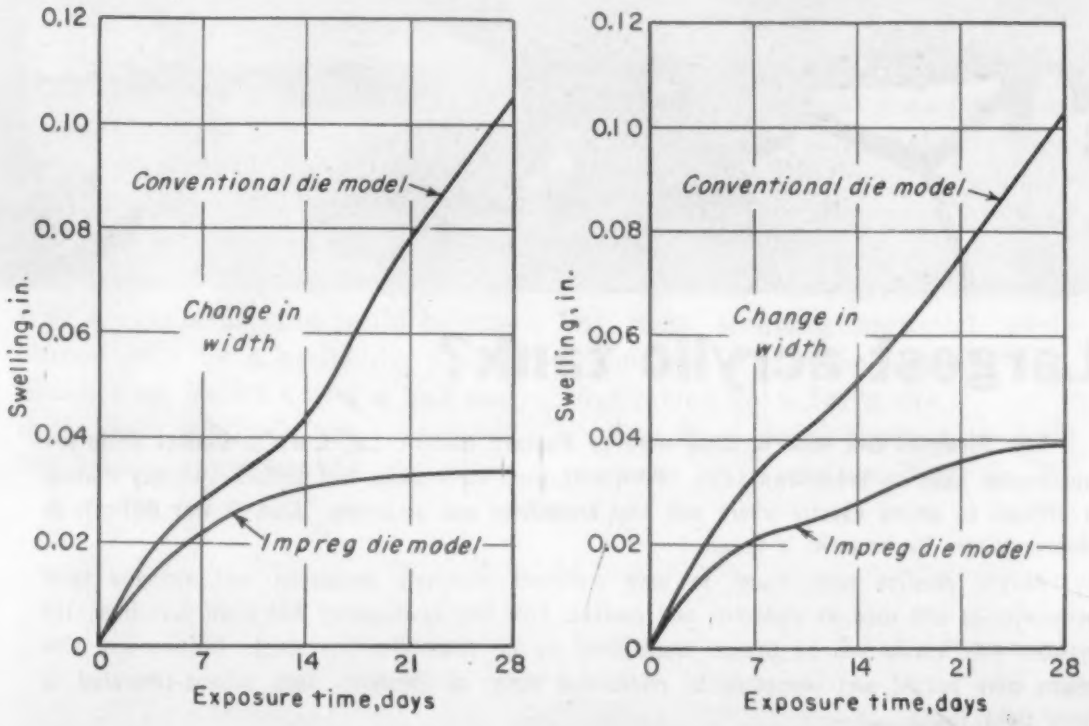
Acrylic plastics were found to have sufficient dielectric properties and virtually total resistance to oils used as dielectric and coolant. Five feet in diameter and eight feet high, the cylinder was heatformed by Crystal Glass from ½ in. thick Plexiglas sheet. Bottom and side seams were butted and supported by reinforcing strips of Plexiglas, then solvent-cemented to form tight joints.

Nickel-clad steel in salt drier

More than 700,000 tons of salt have been dried over the past 18 years in this salt drier made by Lukens Steel Co. The shell is made of ⅜ in. thick 15% nickel-clad steel. In operation, salt is fed into one end and air at temperatures of about 2000 F is fed in the other. The salt comes out completely dry at a temperature of about 360 F. The drier is 66 in. in diameter and 33 ft long. Operated by Barton Salt Co., it has been in operation for almost 18 yr, 16 hr per day, drying salt at a rate of 8 tons per hr.



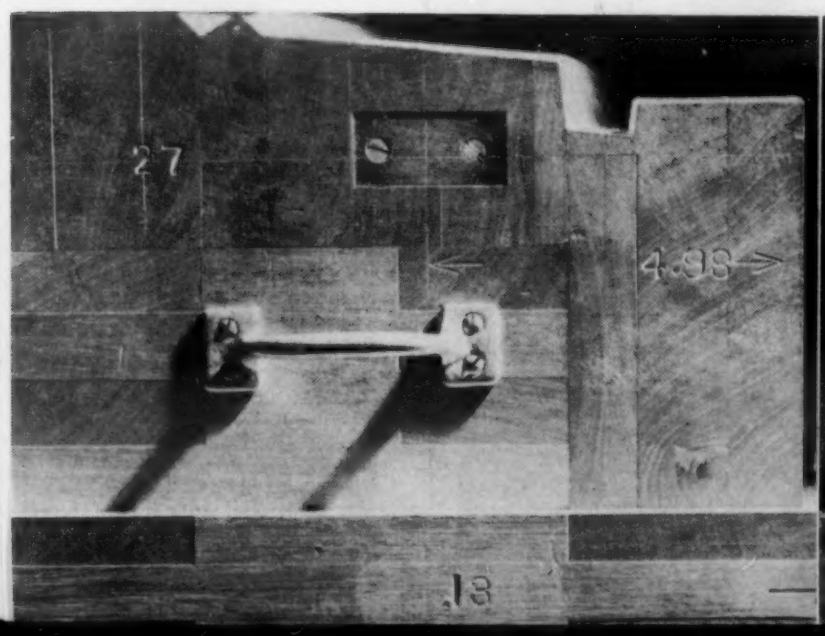
Die model *of automobile roof made from mahogany impreg.*

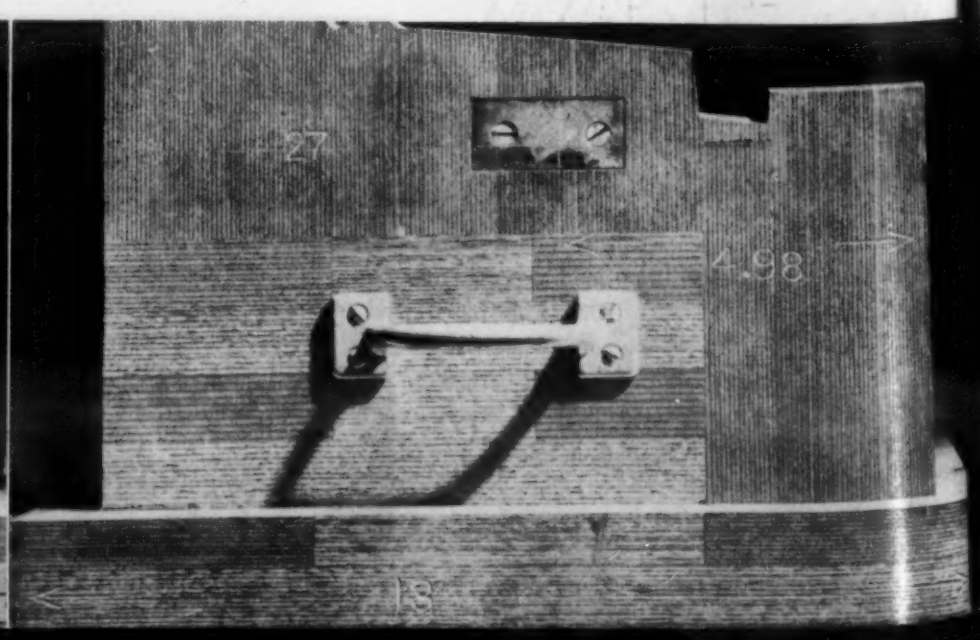


Graphs compare *actual dimensional change in die models of mahogany and impreg subjected to 90% relative humidity.*

Modified wood serves for die models

What happens *to conventional (left) and impreg (right) die models after exposure to 90% relative humidity for one month. Note shadow lines on conventional model which indicate differential swelling of adjacent boards in longitudinal and transverse directions.* ▼





Modified Woods —Old and New

■ *A brief review of the unusual properties of impreg and compreg*
■ *An introduction to three new materials not yet in commercial use*

by **J. K. McDonald,**
Forest Products Laboratory, Forest Service, U.S. Dept. of Agriculture

■ In the past 20 years, the U.S. Forest Products Laboratory has developed several methods of modifying the properties of wood by chemical, thermal and compression treatments. The result has been five different types of modified woods. Two of them, compreg and impreg, have been produced commercially for several years. Compreg is manufactured under various trade names and used in a variety of products. Impreg achieved industrial prominence only recently when the Ford Motor Co. began using it for wood patterns and die models. The other three modified woods—staypak, staybwood and acetylated wood—are not yet produced commercially.

The purpose of most of the Laboratory's work on modified woods has been to increase the dimensional stability of wood. However, most of the modified woods have virtually a whole new range of unusual properties that could be tailored to meet particular requirements. It is believed that when these unsual properties are more widely known modified woods will assume greater industrial importance. This article briefly describes each of the modified woods and gives a bibliography of more detailed publications.

Impreg

Impreg is made by impregnating sheets of wood veneer with phenolic resin-forming chemicals in such a way that the chemicals bond to the internal cell-wall structure of the wood. The chemicals are then dried and cured without pressure within the wood structure. In commercial practice, the treated veneer is first dried to a moisture content of about 10% at a temperature of less than 200 F; then the resin is cured at a temperature of 300-320 F. Treated veneers are usually assembled and glued together with the same resin used to treat the veneer.

Impreg has a number of improved properties compared to those of normal wood and plywood. When it contains 30% of resin, based on the oven-dry weight of the wood, its dimensional stability is 60 to 75% greater than that of untreated wood of the same species. Its moisture-vapor transmission rate is only 0.1% of the normal value.

The resin-treated wood is also less susceptible to grain raising and surface checking, and it is considerably more resistant to attack by decay fungus, termites and marine borers than is untreated wood.

The fire resistance of impreg is about the same as that of conventional wood, but impreg has greatly increased resistance to heat. In one series of tests, for example, impreg was heated to 400 F for one hour, then allowed to cool. This cycle was repeated 50 times with no apparent disintegration of the wood. Untreated wood subjected to the same conditions would deteriorate rapidly.

Impreg is more brittle than the original wood; toughness and Izod impact strength are considerably reduced. However, compressive strength is improved, and modulus of rupture and modulus of elasticity are practically unaffected.

Impreg has high resistance to most chemicals except strong alkalies. Its electrical resistivity at 90% relative humidity is about 1000 times that of normal wood. These properties account for the use of impreg in acid tanks and in housings for electrical control equipment.

Recently the Forest Products Laboratory conducted an extensive series of tests in cooperation with the Ford Motor Co. to determine the feasibility of using mahogany impreg in full-scale patterns and die models for automobile parts. The tests showed that impreg models were 65% more stable than models of untreated mahogany, and that they were generally superior in other properties as well. Impreg was also tested for patterns used for shell-molded crankshafts. Since these patterns are repeatedly heated for an hour at 400 F, both dimensional stability and heat resistance are required. Shells produced with impreg patterns proved very satisfactory, and the use of impreg for this purpose seems promising.

Compreg

Compreg is also made by impregnating wood with phenolic resins, but the dried, treated veneer is compressed while the resin is being cured within the cell-wall structure. Pressures of 1000 to 1500 psi are sufficient to compress most species of wood to a specific gravity of 1.30-1.35. A variety of woods may be used, including normally inferior species such as cottonwood; the only woods that should be avoided are highly resinous woods such as southern yellow pine.

Like impreg, compreg is more

TABLE 1—STRENGTH OF COMPREG[a]

	Psi
Tensile strength (7)[b]	42,500
Modulus of elasticity in tension (1)[b]	4.7×10^3
Crushing strength (8)[b]	23,400
Modulus of elasticity in compr (8)[b]	5×10^3
Modulus of rupture (4)	43,400
Modulus of elasticity in flexure (4)	4.4×10^6
Max shearing strength[b]:	
Modified FPL method (4)	3000
Johnson single shear method (1)	5000
Johnson double shear method (1)	6000

[a]Consisting of 16 parallel laminations of 1/16-in. rotary-cut spruce veneer, each impregnated with 35% of resin (based on dry weight) and compressed 65% in thickness to a specific gravity of 1.32. Figures in parentheses show number of tests on which data are based.

[b]Parallel to the grain

resistant than normal wood to attack by decay fungus, termites and marine borers. The electrical resistance of compreg is similar to that of impreg, but its resistance to the passage of moisture vapor and its acid resistance are considerably greater. Compreg is more flame-resistant than impreg, and flame resistance can be improved by adding phosphate salts to the treating solution.

The combination of resin and compression imparts a high potential polish throughout the structure of the compreg. This natural finish can be brought out with light sanding and buffing. The finish is highly resistant to organic solvents such as alcohol and acetone.

Strength properties of compreg, except for toughness and Izod impact, are increased in proportion to the increase in specific gravity. Results of mechanical tests on compreg panels are given in Table 1.

Compreg is 10 to 20 times as hard as normal wood, and it is extremely resistant to abrasion. As a result, it is somewhat difficult to machine with ordinary woodworking tools, but it can be worked easily with tools normally used on plastics and soft metals such as brass. The material can be glued to itself or to normal wood with hot-press glues or with room-temperature-setting glues. It can also be molded in a press or by expansion-molding techniques.

The beauty and permanence of compreg make it useful for consumer products such as brush backs, knife and utensil handles, golf club heads, novelties and other items. Its dimensional stability and extreme hardness and abrasion resistance make it an excellent material for shuttles, picker sticks and other textile machinery parts. Compreg has also been used for aircraft propellers, antenna masts, forming dies, gears, pulleys, water-lubricated bearings, tool handles and electrical insulators. In Europe compreg is used for insulating fishplates in track circuits; compreg fishplates not only insulate electrically, but also connect the rail ends thereby performing a job normally done by steel fishplates.

Staypak

Staypak is made by compressing wood under controlled conditions of heat and moisture so that the lignin flows sufficiently to eliminate internal stresses. Excessive drying during heating can be avoided by compressing the wood to a specific gravity of 1.30 or higher, which can be obtained with most species at pressures of 1400 to 2000 psi.

The Forest Products Laboratory has produced staypak from solid wood as well as from veneer. Practically all species can be used, but the resinous, pitchy species should be avoided when staypak is produced from solid wood.

Staypak is a much tougher product than compreg. Its impact strength is about double, and its tensile and flexural properties about 25% higher than those of compreg. Since staypak does not contain resin the dimensional stability of the wood is not improved but the normal tendency of wood to recover from compression is almost eliminated. Properties of staypak made from four species of veneer are given in Table 2. Strength properties of staypak, compared with those of normal wood, are roughly in direct proportion to the amount of compression.

Staypak has a natural finish almost as good as that of compreg, but it is inferior to compreg for exterior uses. However, it is potentially cheaper to produce, and it should be suitable for many of the same products, such as shuttles, tooling jigs and dies, spar plates and various fittings, mallets, golf clubs and other products where toughness and resistance to impact are needed.

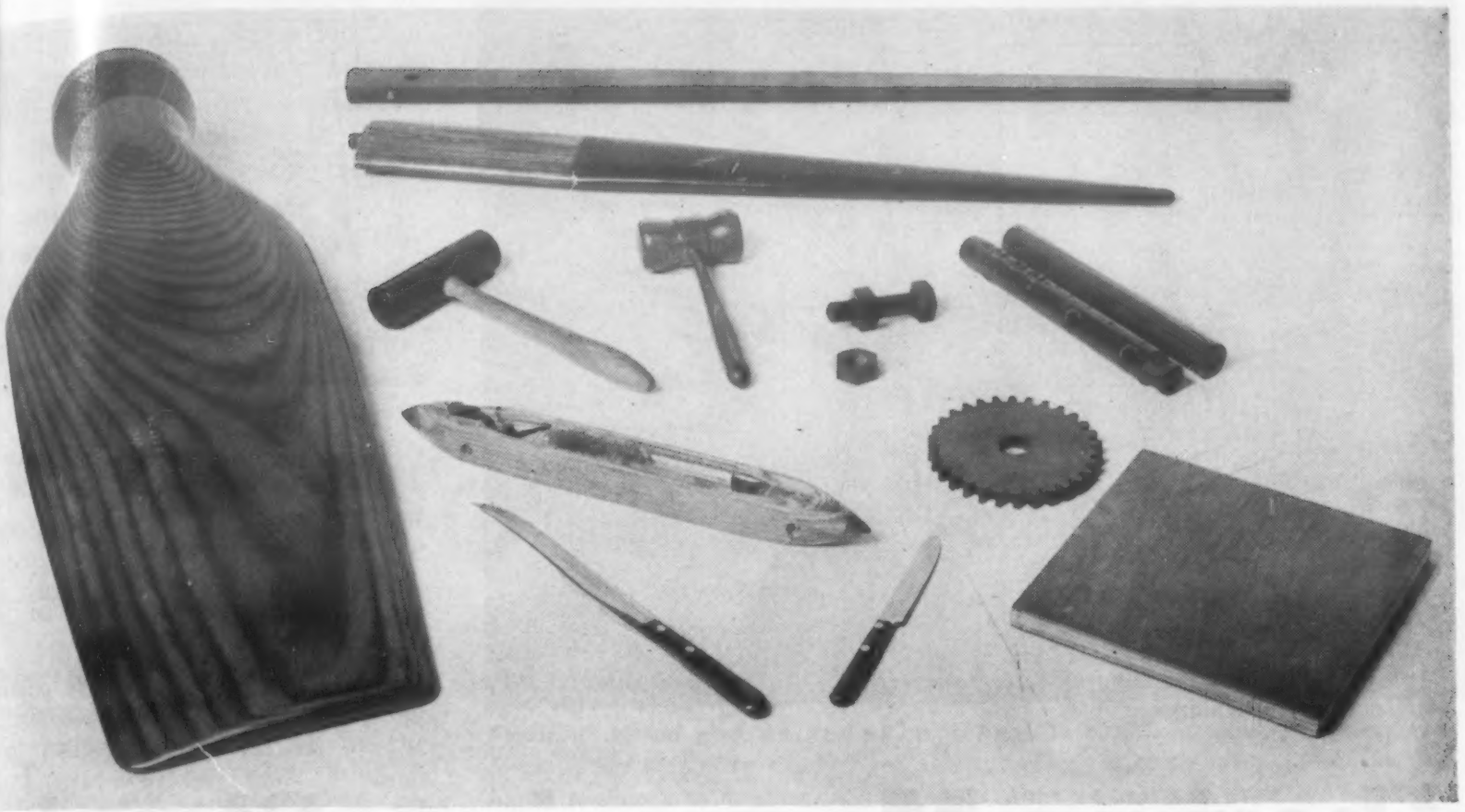
Staybwood

The technique used to make staybwood is the cheapest and simplest method found so far for increasing the dimensional stability of wood. The wood is simply

TABLE 2—PROPERTIES OF STAYPAK (CONDITIONED AT 30% R.H.)[a]

Property \ Type of wood	Sugar maple	Yellow birch	Sweet gum	Cotton-wood
Specific gravity	1.35	1.37	1.33	1.37
Water absorption (24 hr), %	6.0	4.6	4.7	4.0
Shrinkage in thickness from 90 to 30% R.H., %	6.3	5.9	5.7	5.6
Thickness recovery from compression, %	16.9	8.1	10.3	13.0
Static bending:				
Max fiber stress at prop. limit, 10^3 psi	21.0	24.0	19.9	22.6
Modulus of rupture, 10^3 psi	41.0	42.8	37.1	34.9
Modulus of elasticity, 10^6 psi	4.04	4.74	3.71	4.42
Compression parallel to fibers:				
Max fiber stress at prop. limit, 10^3 psi	14.6	14.3	10.8	11.7
Crushing strength, 10^3 psi	23.0	22.9	20.8	21.3
Modulus of elasticity, 10^6 psi	3.90	4.04	3.56	4.11
FPL notched toughness, in.-lb	130	129	123	146
Izod impact, ft-lb/in.	11	11	10	13

[a]Heating time at maximum temperature: 20 min. Test panels about 0.6 in. thick. Each value represents average for eight specimens (two cut from each of four panels).



Typical compreg parts.

heated in such a way as to form chemical crosslinks between the structural units within the wood. At the Laboratory, the heating is done by passing the wood beneath the surface of molten metal or fused salt at controlled temperatures of 500 to 600 F. This process reduces hygroscopicity and equilibrium swelling and shrinking up to 50%, and it makes the wood highly resistant to decay. However, heat treatment results in a serious loss in strength. Toughness, for example, may be less than half that of the orginal wood.

Staybwood has not yet been tested commercially, but it should be suitable for such uses as window sash and frames where improved decay resistance and dimensional stability are more important than strength.

Acetylated wood

Acetylated wood has the highest dimensional stability of any of the modified woods. Equilibrium swelling and shrinking have been reduced 60 to 70% with an increase in specific gravity of only 6 to 12%. Moisture transmission is reduced to about one-fifth of normal, and the wood has greatly increased resistance to decay, termites and marine borers. Most of the strength properties are unaffcted, but toughness and Izod impact strength are increased as much as 20%.

In the acetylation process used by the Laboratory, dry veneer is placed in an acid-resistant, airtight chamber maintained at atmospheric pressure. Air intakes are closed, and a mixture of liquid acetic anhydride and pyridine is introduced into a tray below the load. Air is circulated over the tray and through the load at a temperature of 170 to 250 F until acetyl groups equal to 18-25% of the weight of the wood are introduced into the wood structure. The tray is then drained and heated air is circulated through the load to remove excess chemicals and odors.

The corrosiveness and toxicity of some of the materials used in this process pose difficult engineering problems. Hence, acetylated wood is not produced commercially, but it holds promise for uses that require a tough, stable product that is highly resistant to decay.

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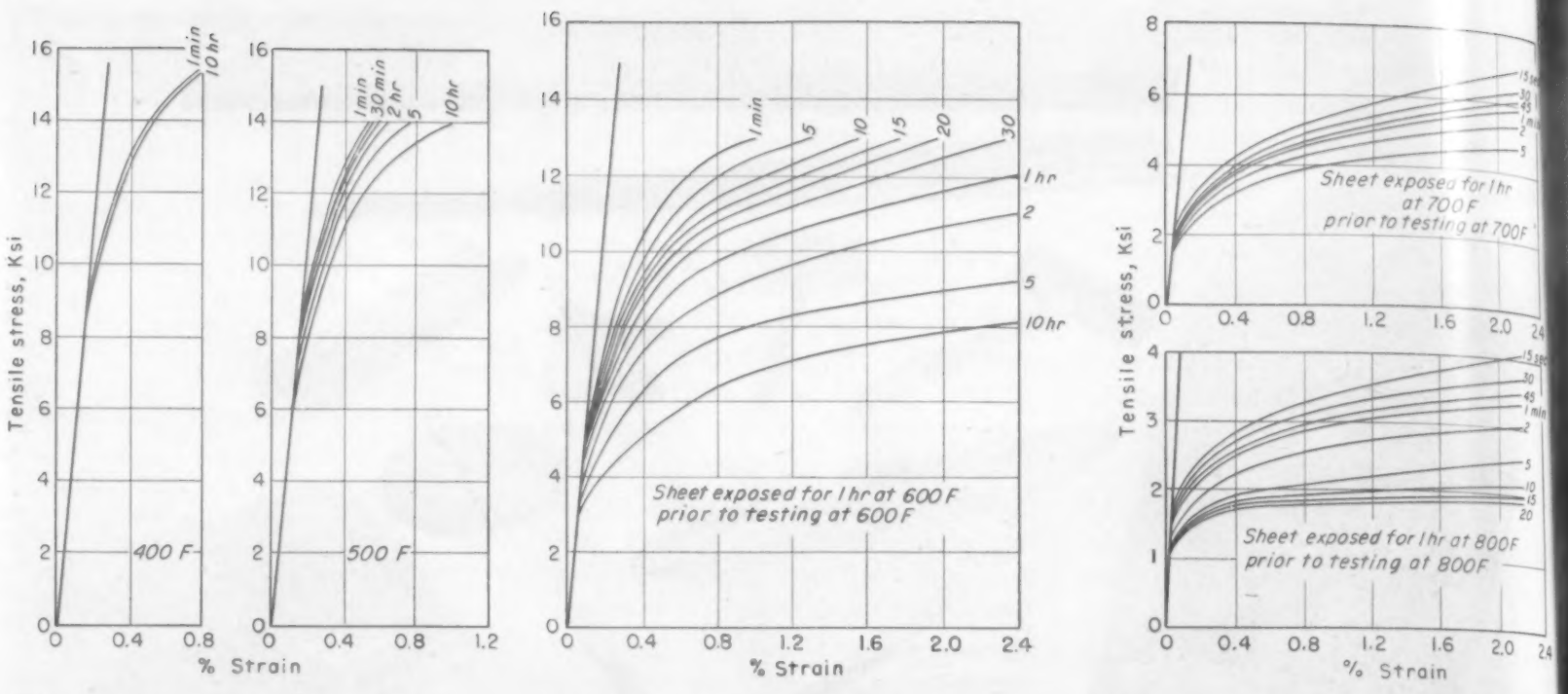


These short-time stress strain curves for HK31-T6 sheet are valuable to the designer of short service life guided missiles and powerplants.

Thorium-Magnesium Sheet

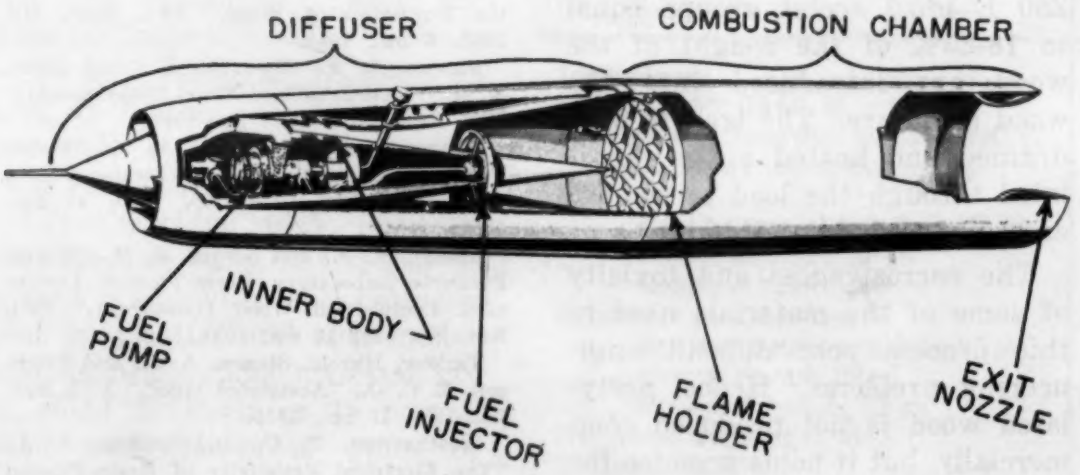
Useful for High Temperature Service

Light weight, strength at elevated temperatures and good forming properties make this alloy attractive for new missiles and aircraft powerplants.

by Alan V. Levy,
Supervisor, Materials and Process Section, Marquardt Aircraft Co.

■ Aircraft are primarily designed around the light structural alloys of aluminum. However, some of the latest missiles and aircraft already past the drafting board stage are designed to fly at speeds where their body temperatures will be so high that the remaining strength of current aluminum alloys is not sufficient to carry the required loads. The search for a material capable of functioning satisfactorily in the 500 to 600 F range has concerned many aircraft materials engineers. Until recently, the only alternative to aluminum has been iron-base alloys.

A recently developed magnesium alloy, designated HK31 and containing 3% thorium and ¾% zirconium, has properties which are attractive for service in this temperature range. This alloy weighs about ¼ as much as steel, retains high strength and elastic modulus to temperatures of about 600 F, has good creep resistance, can be heat treated and welded and is available in cast and wrought form.



***The ramjet engine** is essentially an open-end thin wall pressure vessel and the simplicity of fabricated shapes is one of its attributes.*

The interesting properties of HK31 led to its evaluation for use in a new supersonic ramjet engine designed for service at temperatures above 600 F. Since the ramjet engine is constructed essentially of sheet metal, evaluation was limited to a determination of the properties and fabrication techniques for material in this form *(Editor's note: Properties of cast HK31 were given in an article in the July 1954 issue of* MATERIALS & METHODS).

Fabrication of the forward, aerodynamic section of this new engine showed that HK31 could be formed and joined satisfactorily.

Properties

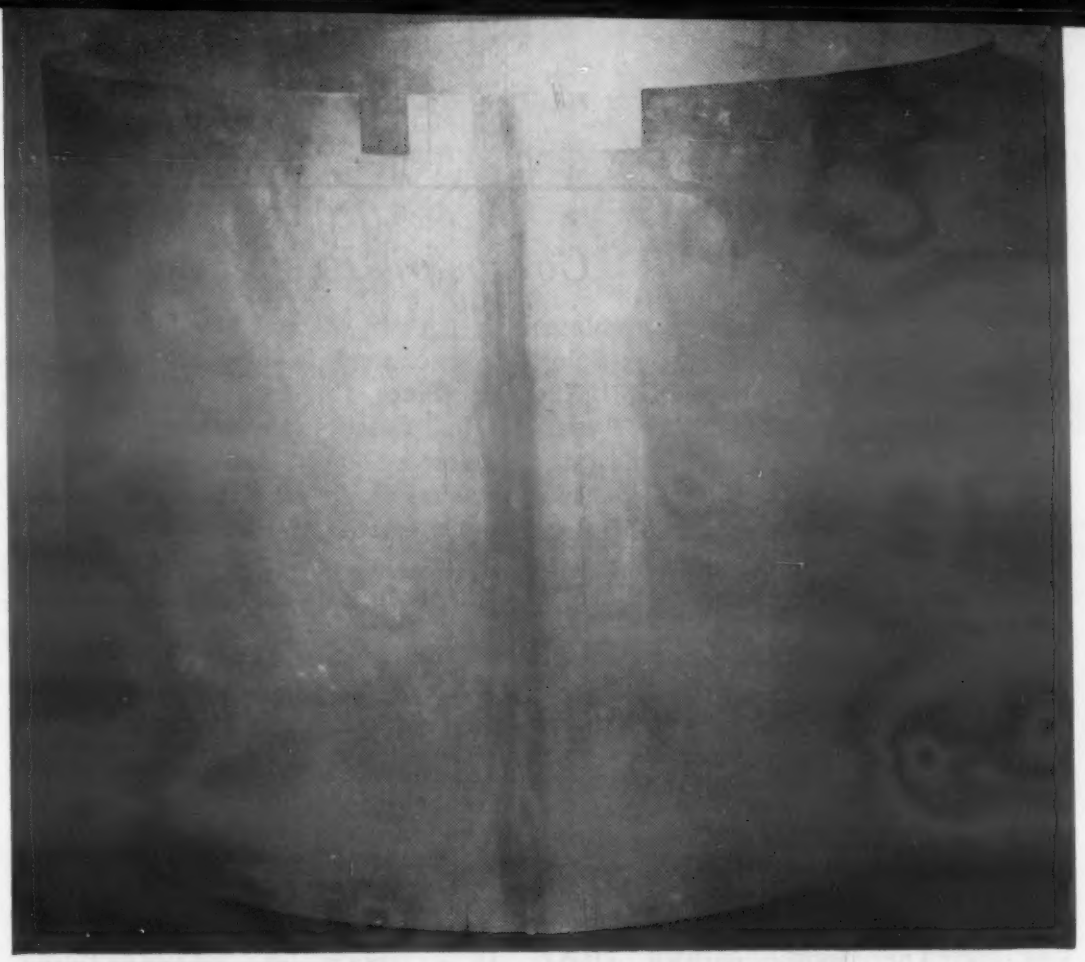
Elevated temperature mechanical properties of HK31 in the H24 (cold worked) and T6 (heat treated and aged) conditions are given in a table. Properties of aluminum alloy 2024-T3 are included for comparison. With increasing temperature, aluminum alloy 2024-T3 loses strength more rapidly than HK31-T6 and at 600 F their tensile and yield strengths are comparable. The ductility of the magnesium alloy is higher at all elevated temperatures. Fusion welds of HK31 show joint efficiencies of 100% at temperatures above 400 F making the alloy attractive to the ramjet designer.

Fatigue test results are summarized in another table. For operating temperatures of 400 F or higher, the stresses shown are reasonable fatigue stress levels for a service life of at least 300,000 cycles. The short time stress-strain curves plotted in several figures for temperatures of 400 to 800 F will be useful to the designer of parts or structures which are intended for short service life.

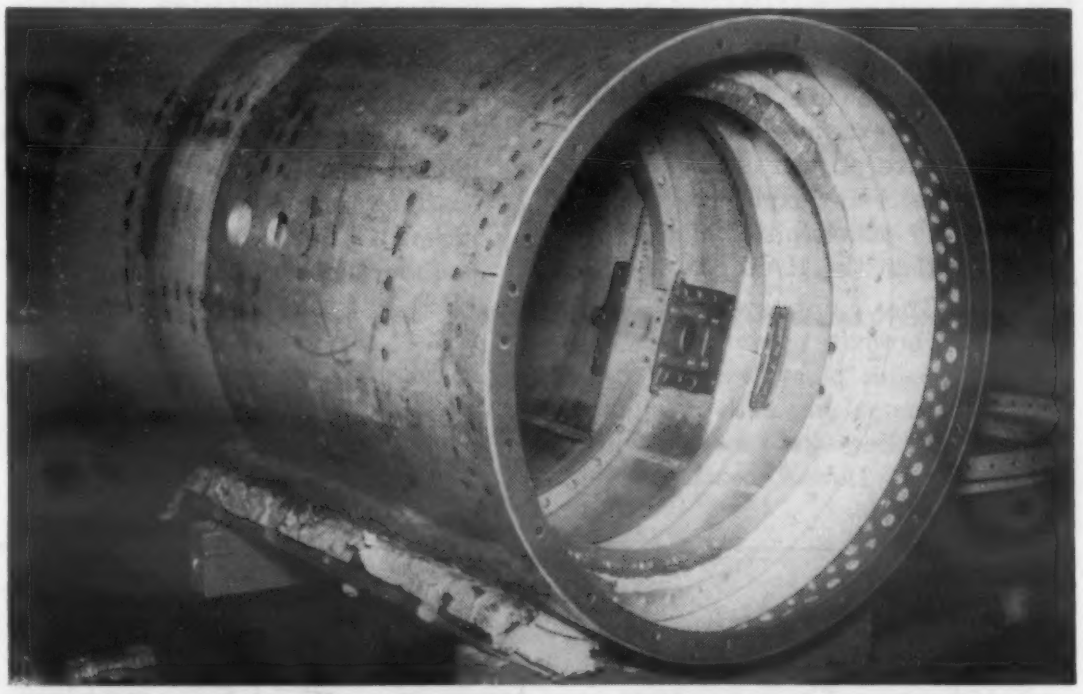
Fabrication properties

In general, wrought HK31 can be fabricated by the same procedures employed for AZ31. The major difference in forming the two materials is temperature. For hot-forming operations in which AZ31 is formed at 400 to 500 F, it is necessary to heat HK31 to 600 to 700 F to obtain the same degree of formability. The effect of heating on formability is indicated in a table comparing minimum bend radii for HK31 at room temperature and 600 F.

Forming methods used at Marquardt for ramjet engines are usually limited to those producing simple or developed surface cylinders and cones. Simplicity of fabrication is one of the attributes of the ramjet engine. The fairly large diameters used (12 to 50 in.) enable most parts to be rolled on a set of standard 8 in. rolls and, if necessary, subsequently welded and spun to final



Typical rolled and welded skin. *Using the standard techniques developed for welding this alloy and progressively welding a 40 to 80-in. joint, the part had a tendency to assume an hour-glass shape in the weld area due to shrinkage stresses. This tendency was overcome by using tack welds 3 in. long spaced at 3-in. intervals and selectively filling the gaps between.*



Several types of mechanical fasteners *are used in assembling the engine. This typical innerbody assembly contains some internal rings made from spun 2024 aluminum. All other parts are HK31 magnesium.*

Corrosion Resistance of HK31

Corrosion protection problems were investigated by exposing a series of panels of HK31-H24 treated with a number of coatings to sea air and to tidewater immersion in the Pacific Ocean at Malibu Beach, California. The results obtained after 1 to 2 mo exposure indicate that:

1. Monel rivets corrode magnesium, regardless of hole protection. Best protection for dissimilar metal rivets is a good paint coating over the rivets and the surrounding base metal after assembly to, in effect, seal off the joint.
2. The light, oatmeal HAE coating does not give satisfactory protection, even compared to full HAE bare and is not a good paint base. Full HAE or Dow 17 bare do not provide sufficient protection. Their pores must be sealed.
3. Dow 17 and HAE, suitably sealed are equally resistant to extended salt air exposure. Under salt water immersion exposure, the Dow 17 panels pitted slightly more than the HAE coated panels.
4. The paint systems of zinc chromate primer or epoxy resin plus phenolic baking enamel are both excellent for sealing the anodic coatings and Dow 7 coating. Epoxy resin without phenolic baking enamel is also satisfactory.

Since the engine is required to function at temperatures above 600F, tests were performed to determine relative protective abilities of several coatings after they had been exposed to a temperature of 600F for ½ hr. Coatings were applied on bare and HAE treated magnesium panels. Panels were exposed to 54 days salt air exposure and a set of coated panels which had not been HAE treated was exposed to alternate salt water immersion for 14 days. Here are the results:

Zinc chromate primer—Applied over HAE, the primer with phenolic overcoating provided satisfactory protection to the magnesium even though it had been turned dark brown by the 600 F heating cycle. Applied on bare magnesium, the primer lost its adherence at about 400F and tended to peel off the bare metal surface.

Epoxy resin—This material exhibited the best protection of all coatings tested, even after exposure to 700F for ½ hour. It had excellent adherence to the HAE coating and to the bare HK31. Even on the bare magnesium, it protected the surface adequately.

Aluminum paint—This type coating adhered satisfactorily to the bare magnesium, but did not provide adequate corrosion protection.

Silicone paint—This material did not provide corrosion protection when compared to the epoxy resins.

A final series of tests was performed to determine an alternate insulator for zinc chromate primer for dissimilar metal contacts, especially riveted joints. This is necessary because zinc chromate on bare magnesium, such as occurs in rivet holes, deteriorates excessively at elevated temperatures. It was found that the use of the epoxy resin on fastener holes before inserting the fastener and subsequent painting of the whole joint area was required for all mechanical joints used in the engine. For lower temperature applications, zinc chromate primer and phenolic paint are satisfactory.

It should be understood that the ramjet engine application at this time does not require indefinite corrosion resistance to all types of atmospheres. For this reason, tests were somewhat limited in duration. However, the protection systems that stood up best and were used in engine designs had not begun to deteriorate at the end of the test periods used.

shape. Spinning of a developed surface cone, longitudinally welded with the bead ground flush, from 0.033 in. H24 was readily accomplished by torch heating to 600 F during the spinning operation.

The general characteristics of HK31 indicate that it can be formed into complicated shapes by any forming process which permits heating to 600 or 700 F and holding that metal temperature during the forming operation. The material forms equally well in the T6 and H24 condition and loses no strength during heating in this range for durations not exceeding 5 to 10 min. Thus, there is little need to heat treat the material to T6 as a fabricating step if it can be obtained from the producers in the T6 condition.

Heat treatment

If the material is received in the H24 condition, it must be heat treated to the T6 condition to obtain the properties required for elevated temperature service above 500 F. To produce the T6 condition, the Dow Chemical Co. recommends the following treatments:

Solution heat treatment: Heat to 1050± 10F in a sulfur dioxide atmosphere (3% minimum SO_2) and hold at temperature for 30 min. Forced air cool to 600F in 5 min and air cool to room temperature.

Aging treatment: Age at 400± 10F for 14 to 18 hr and air cool.

BENDING DATA

Metal Thick. in.	Minimum Measured Bend Radius in.		Min Recommended Working Bend Radius, T (T = thick. of metal)	
	70F	600F	70F	600F
0.083	3/16	1/8	3.5 T	2.0 T
0.125	5/16	1/4	5.5 T	3.0 T
0.188	15/16	5/16	6.0 T	4.0 T

FATIGUE PROPERTIES

Condition	Temp, F	Mean Stress, psi	Max Stress, psi	Total Cycles	Remarks
HK31-H24 (unwelded)	70	15,500	17,800	330,000	No Failure
	400	10,000	11,500	350,000	No Failure
	600	4000	4600	305,000	No Failure
HK31-H24 (as-welded, bead on)	70	15,500	17,800	210,000	Failed edge of weld
	500	10,000	11,500	300,000	No Failure
HK31-T6 (welded in H24 condition, heat treated to T6, bead on)	70	15,500	17,800	150,000	Failed, edge of weld
	500	10,000	11,500	310,000	No Failure
	600	4000	4600	315,000	No Failure

Welding

The ramjet engine is essentially an open-end, thin wall pressure vessel. Any pressure leakage through the skin lowers the engine performance. For this reason and because fusion welding of butt joints in sheet metal is the neatest and most economical method of making a joint, much interest in HK31 was created by its ability to be welded successfully. However, the fusion welding of this material requires a few special techniques to produce sound, high quality welds.

As received material in the H24 condition which has been pickled at the mill needs further cleaning before welding to remove a tenacious oxide. This oxide is removed by alkaline or solvent cleaning of the joint area by immersion in a 20% chromic acid-3% potassium nitrate solution at room temperature for approximately 10 sec, rinsing in hot water and air drying. Wire brushing can be used as an alternate to nitrate pickling.

An a.c. welder supplies power for the inert-gas-arc welding method used. For metal thicknesses up to 0.125 in. a single Vee, 60 deg included angle butt joint is preferred. Filler metal consists of strips of the base metal cut approximately ⅛ in. wide and smoothed on the cut edges to eliminate expulsion of minute metal particles during welding. Argon flowing at the rate of 12 to 15 cu ft per hr is used as the cover gas and a backup bar of steel is required. Manual welding speeds of 9 in. per min using 50 to 210 amp produces sound welds without undercutting or lack of fusion.

Most critical requirements for welding are preheat and electrode angle. The alloy must be heated to 450F and the temperature of the backup bar must not be allowed to fall below 400F. An angle of 90 deg between work and electrode and about 30 deg between filler rod and sheet yields satisfactory results. Varying the electrode angle or dropping the preheat below 400F results in a decided tendency to undercut because of erratic arc conditions.

After completion of the weld, the drop-through on the underside of the joint must be chipped off almost flush with the base metal and a fusion pass using no filler metal must be run down the underside at about 12 in. per min. This results in a sound joint.

Assembly

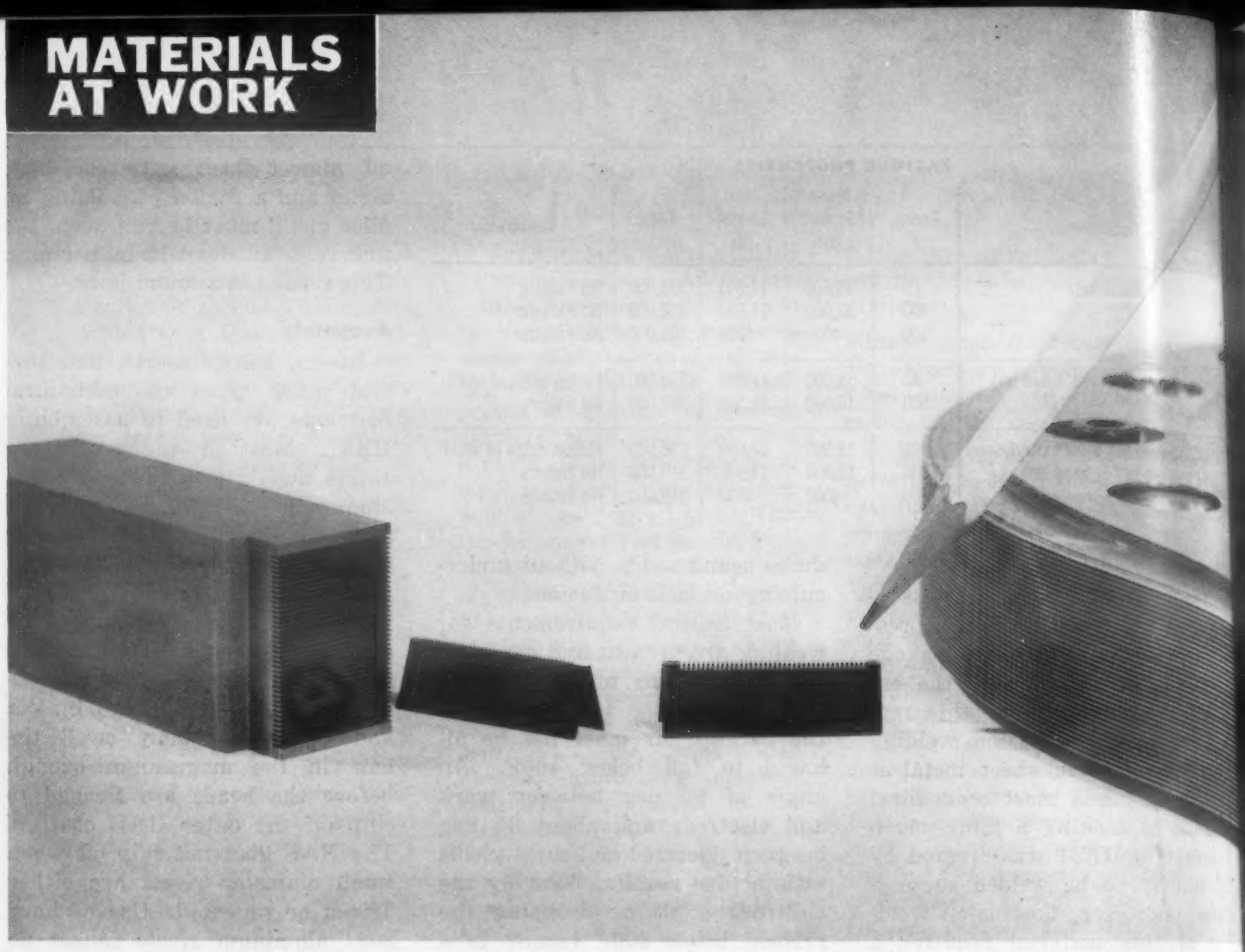
Rivets, bolts, inserts, and several other types of mechanical fasteners are used in assembling HK31. Most of the rivets are single flush rivets made of 2024 aluminum. Rivet holes are drilled and countersunk and painted with a liberal coating of epoxy resin prior to insertion of the rivet. Rivets are gun driven or squeezed depending on the location. Hard 2024 aluminum rivets in the larger sizes (3/16 in. dia and up) unavoidably swell the hole in the magnesium enough before the heads are formed to chip off the outer HAE coating. The HAE does not chip off when small diameter rivets are either driven or squeezed. Use of hard 2024 aluminum rivets causes no hole damage when driven into the softer magnesium other than chipping the HAE. Riveted joints are painted over with epoxy resin to seal them against corrosion.

STRENGTH OF HK31 MAGNESIUM SHEET COMPARED WITH 2024 ALUMINUM SHEET

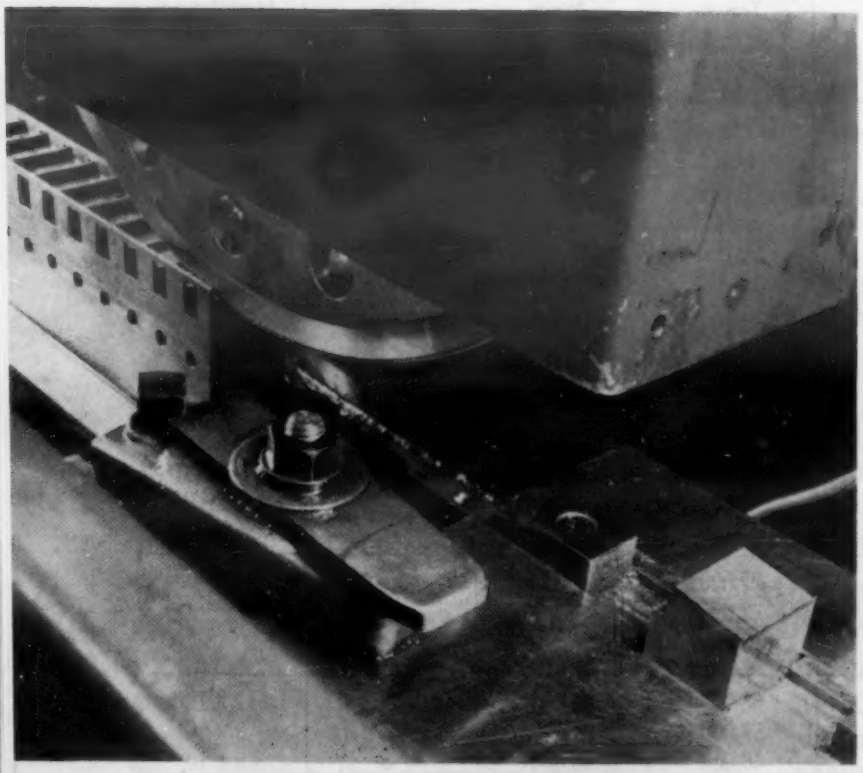
Material and Condition	Temp, F	Tensile Strength, psi	Yield Strength, psi	Elong, % 2 in.	Modulus of Elasticity psi
Magnesium HK31-H24	70	37,000	29,000	8	6.6×10^6
	300	26,000	23,000	20	6.1×10^6
	400	24,000	22,000	21	5.7×10^6
	500	20,000	18,000	19	4.7×10^6
	600	13,000	7000	70	3.7×10^6
HK31-T6	70	37,000	21,000	14	6.4×10^6
	300	25,000	16,000	19	5.9×10^6
	400	22,000	14,000	19	5.8×10^6
	500	20,000	14,000	21	5.5×10^6
	600	18,000	11,000	22	5.4×10^6
	700	9000	5000	56	
	800	4000	2600	136	
HK31-T6 as welded	70	27,000[a]		3.5	
	400	22,000[b]		5	
	600	19,000[c]		14	
Aluminum 2024-T3	70	68,000	46,000	19	11×10^6
	300	57,000	41,000	15	9×10^6
	400	46,000	40,000	8	8.5×10^6
	500	36,000	34,000	6	6.5×10^6
	600	16,000	15,000	12	5×10^6
	700	7000	6000		

Failure location [a]*weld*
[b]*heat zone*
[c]*base metal*

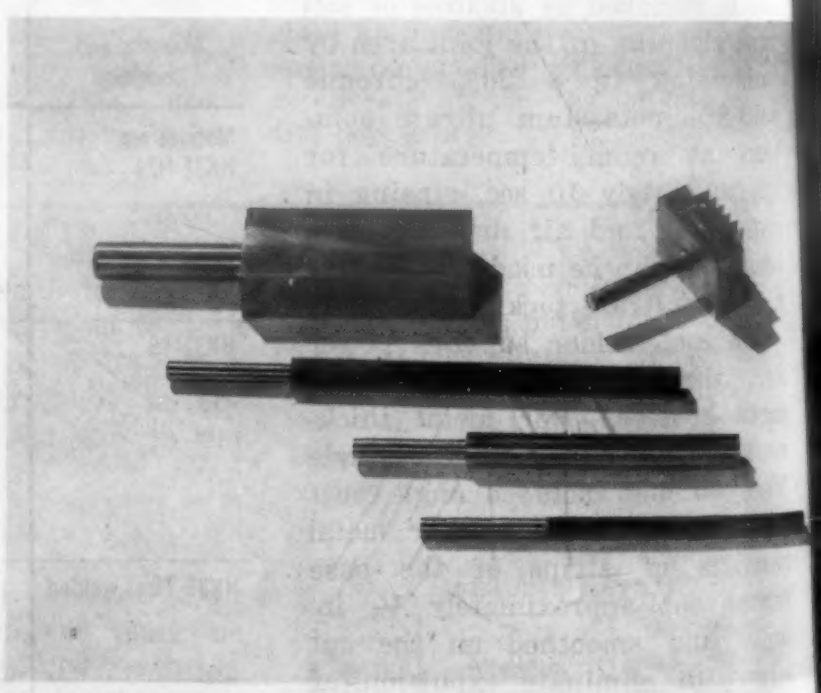
MATERIALS AT WORK



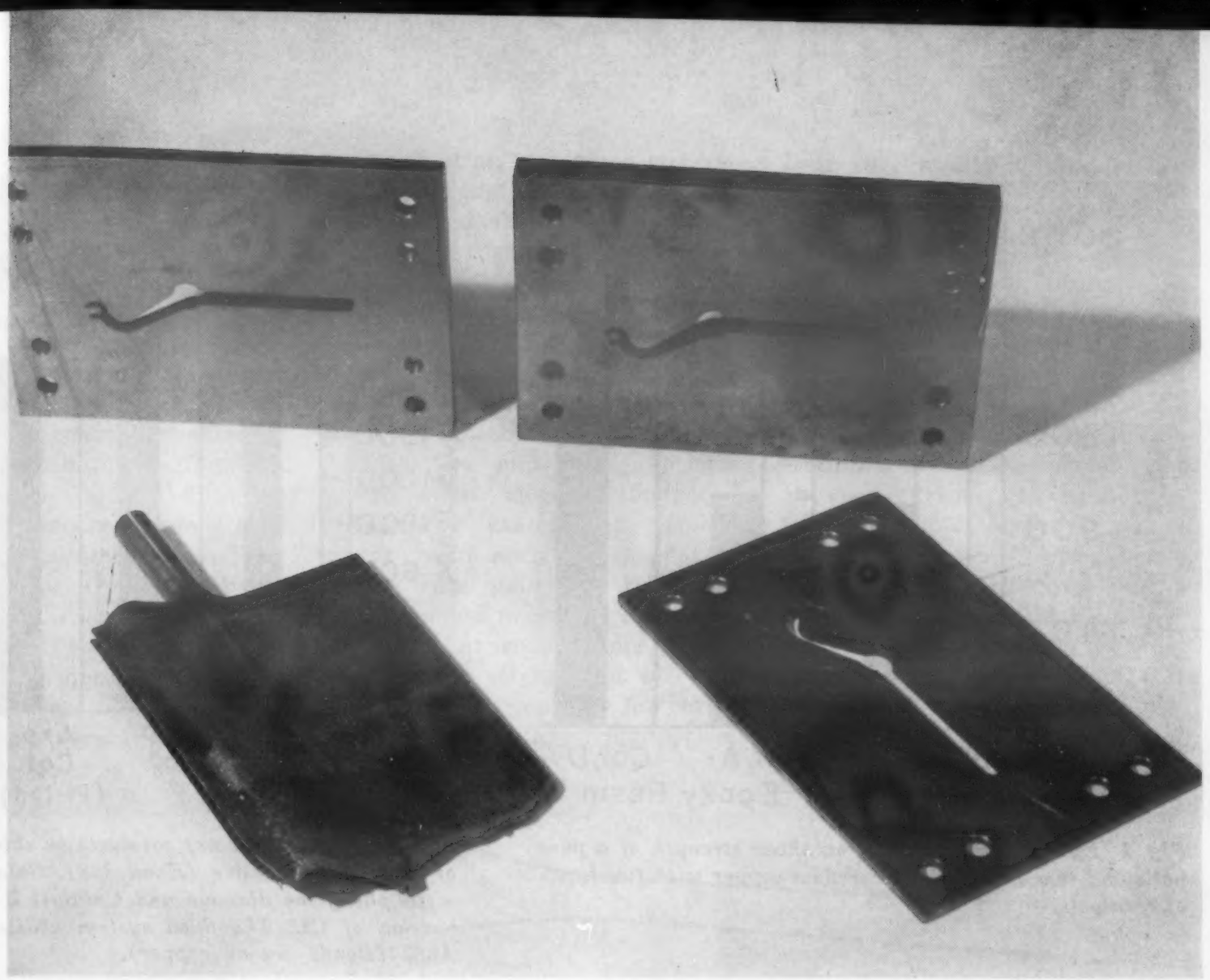
***Electric shaver heads** are shown in center after grinding. At right is brass cutting wheel and at left, wheel dressing tool.*



***Shaver heads** are shown set up for machining with the brass wheel in place. Coolant has been omitted for clarity.*



***Various shapes** in brass electrodes used for vertical "plunge" grinding.*

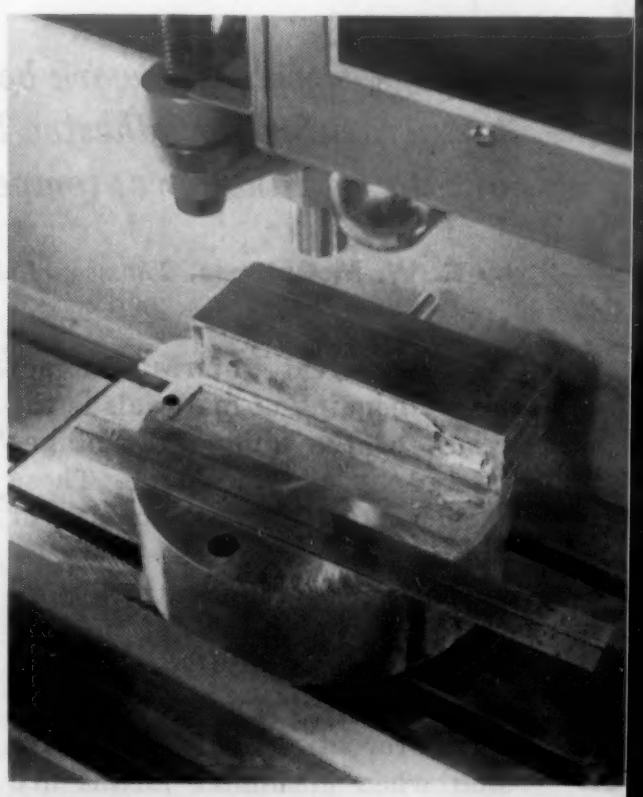


This die, base plate, and stripper *have been machined in one step by the brass electrode at lower left. The three elements are assembled before machining by means of location holes at ends, thus assuring positive alignment of cavities.*

Brass machines hardened steel

Free cutting brass (65 copper-35% zinc) plus electricity can form, shape, pierce or grind hardened tool steels and similar hard-to-machine metals by the method known as electrical discharge machining. The pictures on these pages show some of the wide variety of shapes which can be formed quickly and accurately in hardened die steels by the method. Ground surfaces have a matte finish, with a surface roughness of 10-20 microinches.

Developed by Elox Corp., the process makes use of a brass electrode which is shaped in the obverse of the desired pattern. In operation, work blank and electrode are submerged in a dielectric fluid coolant. Sensitive servos maintain a gap between electrode and work of 0.0002 to 0.0015 in. When power is turned on sparks arc across the gap at a rate of 20,000 to several million times per second. Each discharge vaporizes several microns of metal, eroding a shape identical to that of the brass electrode. Vaporized metal is washed out of the gap by the dielectric fluid. There are no physical pressures to cause spindle vibration, scratching of the work or chatter marks.



Finished forging die *for turbine compressor blades is shown with brass electrode (on its side on top of die).*

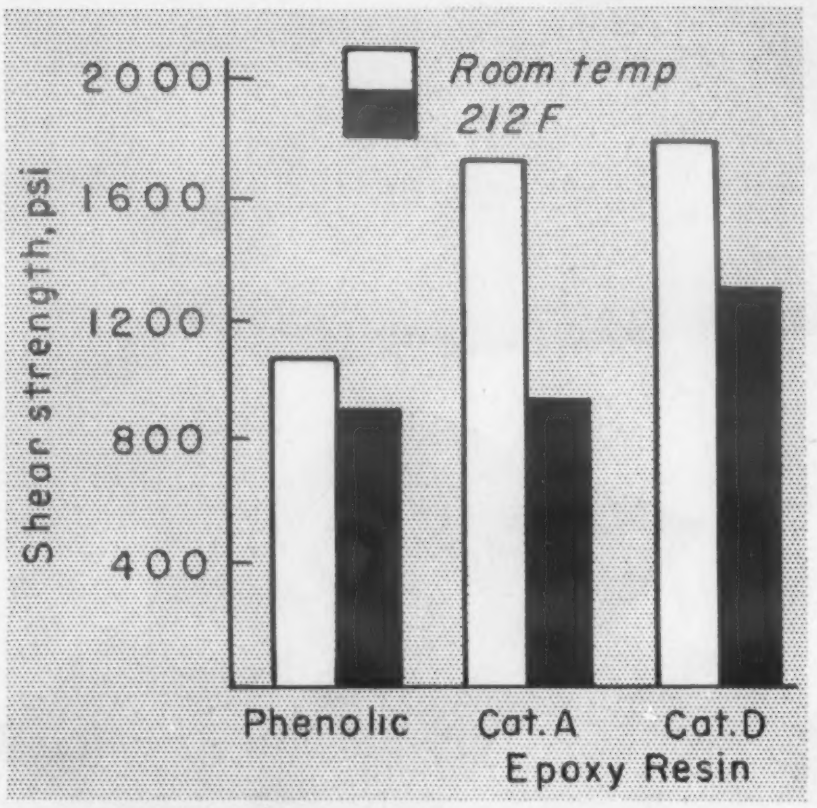


Fig 1 *Effect of temperature on shear strength of a phenolic and two epoxy resins cured on copper with two types of catalysts.*

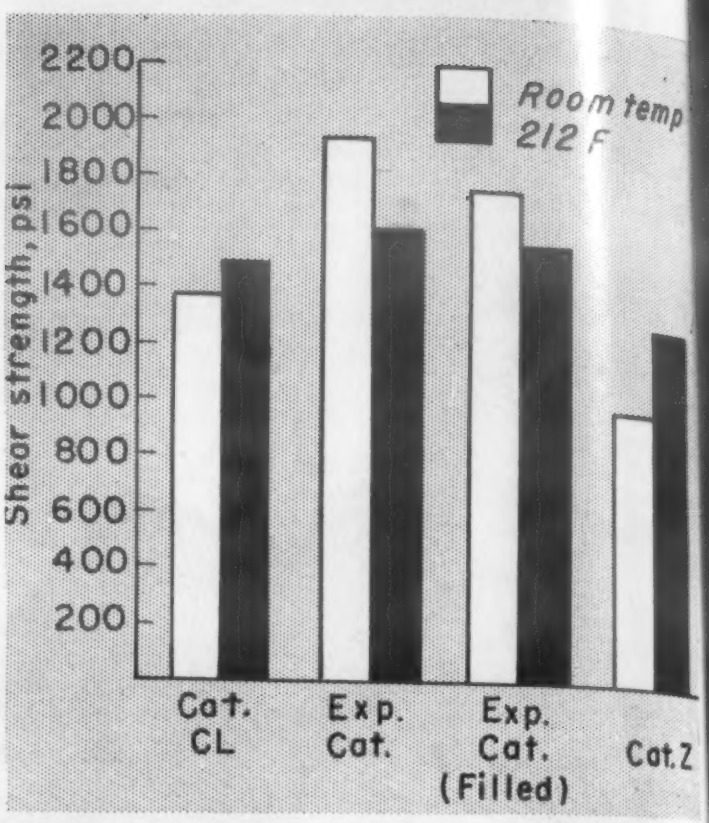


Fig 2 *Effect of different catalysts on shear strength of an epoxy adhesive (Epon 828). Catalyst CL is meta phenylene diamine and Catalyst Z is a liquid version of CL. The filled system utilizes 60 parts Al_2O_3. (Bonds are on copper).*

How High Temperatures Affect

Epoxy Adhesives

Here is a report on work being done to raise the allowable service temperatures for adhesive bonded structures. The author points out the effect of catalysts and cure; temperature and aging on some epoxy adhesives.

by E. W. McGuiness, *Thomson Laboratory, General Electric Co.*

■ The current interest in adhesive bonding of materials is the result of the unique advantages offered by the technique. These include: 1) it permits bonding of dissimilar materials, 2) it is carried out at low temperatures eliminating possibilities of change in properties of the materials joined; 3) resins used are insulators preventing galvanic corrosion when dissimilar metals are joined; 4) it provides leak proof joints; and 5) it provides equalized stress distribution over the joined area. One of the major problems in the adhesive bonding field is developing adhesives which will withstand the ever-increasing service temperature to which bonded materials are exposed.

Epoxy resin adhesives do not have the wide degree of temperature resistance offered by welding, brazing, riveting or other methods of joining metals. However, they can give a wide range of properties depending on the type of catalyst system used. Resins cured at room temperature have short pot life and reasonably good strength. Oven-cured resins generally provide better room temperature strength, longer catalyzed pot life and have greatly improved strength at elevated temperatures. Post-curing at elevated temperatures also improves high temperature strength. Use of fillers can improve high temperature strength as well as shock resistance and thermal conductivity of the resin.

Thermal degradation of epoxy resins after extended heat aging at elevated temperatures seems to be a function of the catalyst used.

Triethanol amine provides excellent retention of properties after one year at 257 F. Shell Catalyst A also provides good strength retention after six months at 257 F.

Room temperature vs oven cure

The chief virtue of room temperature curing systems is ease of fabrication. No ovens are necessary and only enough pressure is required to maintain surfaces in contact. Resins can be filled to give any desired consistency and thus achieve minimum run-off of resin. Due to their relatively short pot life, room temperature curing resins must be mixed in very small quantities. Shear strength of these resins is quite good but considerably below the strength of an oven-cured material. Hot strength of room temperature cured resin is also much lower than that of the oven-cured types.

Use of an oven-cured resin adhesive results in improved properties that can compensate for additional cost. The oven cure provides better strength at room temperature and also superior strength at elevated temperatures. For example, a typical epoxy resin such as Epon 828 cured with diethylene triamine, when applied to copper and aged overnight at room temperature, has a shear strength of 600 psi which remains constant for three weeks. On the other hand, a two hour cure at 212 F doubles the shear strength.

Effect of temperature

There is a great difference in the strengths of epoxy resins at room temperature and at 212 F, when cured with commonly used catalysts. Fig 1 compares the effect of temperature on shear strengths of a phenolic resin and an epoxy resin oven-cured with two types of catalysts. The phenolic adhesive has lower shear strength than the epoxy, but is affected less by the 212 F temperature.

Catalyst D (2-ethyl hexanoic salt of tri[dimethyl amino methyl phenol]) provides a good balance of

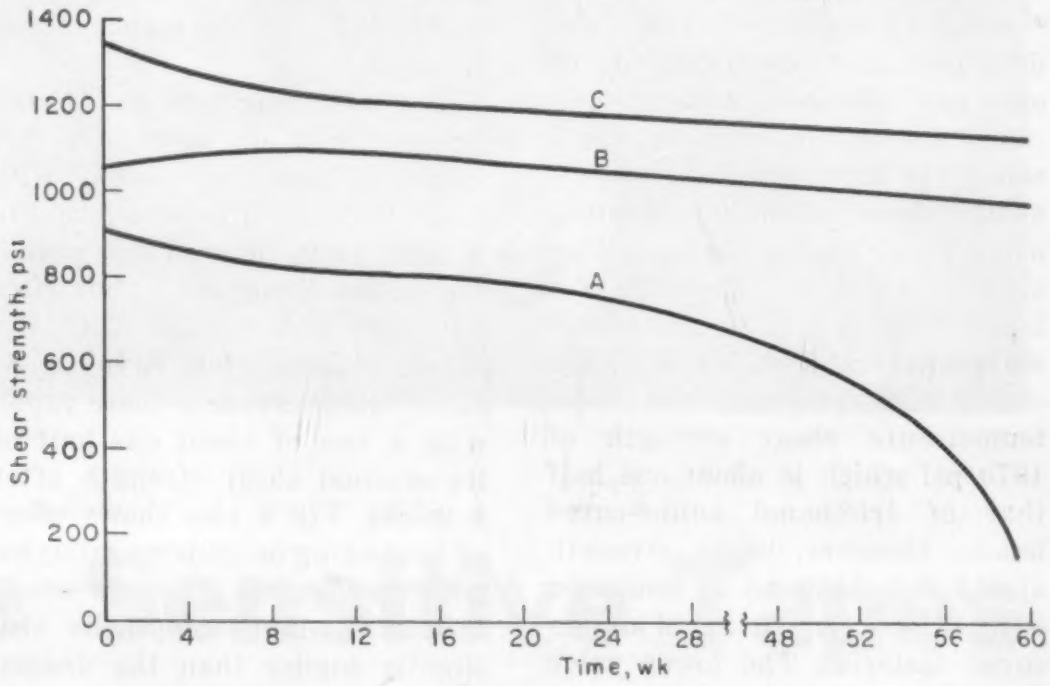
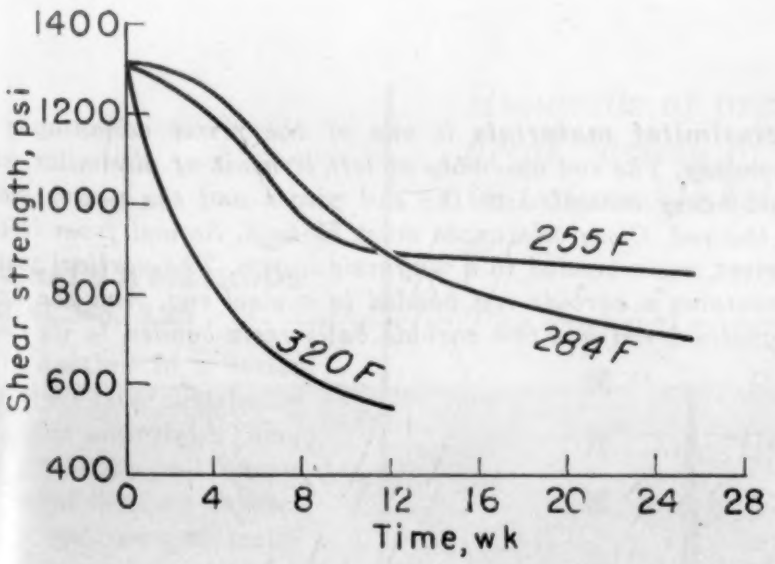


Fig 3 *Effect of heat aging at 255 F on a phenolic and epoxy adhesive. Curve A is phenolic, B is Araldite CN 503 cured with triethanol amine, and Curve C is the same as B except that 60 parts Al_2O_3 have been added. (Bonds are on copper).*



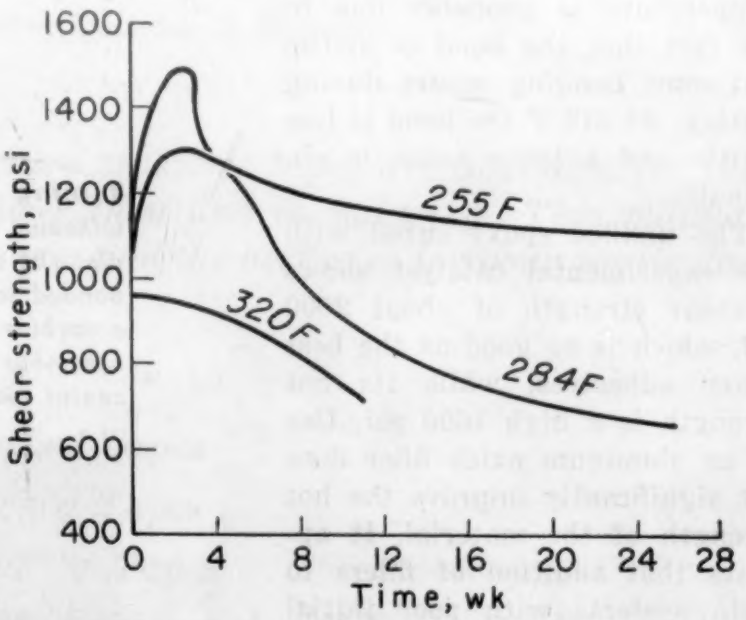


Fig 4 *Curves at left show effect of heat aging at various temperatures on Epon 828 epoxy catalyzed with Catalyst D. Curves at right show effect of heat aging at various temperatures on Epon 828 catalyzed with Catalyst A. In the latter curves, initial increase in strength is probably due to increased cure. (Bonds are on copper).*

properties. It has good room temperature shear strength, about 80% of which is retained at 212 F. It should also be pointed out that Catalyst D provides a resin with a pot life of from 12-18 hr and can be cured to maximum strength after two to three hours at 212 F. Catalyst A (3-diethylamine propylamine) provides a pot life of only about 3 to 4 hr at room temperature, and cures in about 3 hr at 212 F. As can be seen in Fig 1, strength retention of this system at 212 F is not as good as that of a resin cured with Catalyst D. It should be remembered that these values are for epoxy adhesives on copper. **Strength values for epoxy resins bonded to aluminum are about twice those of copper.**

Specialized catalysts have been developed and are being developed particularly to solve the elevated temperature problem. Fig 2 shows the improved high temperature shear strength obtained using epoxy (Epon 828) and Catalyst CL; Catalyst Z, which is a liquid version of CL; and an experimental catalyst. Catalyst CL shows a surprisingly low room temperature shear strength of 1370 psi which is about one half that of triethanol amine-cured bonds. However, shear strength at 212 F is 1480 psi as compared with 437 psi for triethanol amine-cured material. The lower value for CL-cured material at room temperature is probably due to the fact that the bond is brittle and some bending occurs during testing. At 212 F the bond is less brittle and a truer value is obtainable.

The unfilled epoxy cured with the experimental catalyst shows a shear strength of about 2000 psi, which is as good as the best epoxy adhesives, while its hot strength is a high 1600 psi. Use of an aluminum oxide filler does not significantly improve the hot strength of the material. It appears that addition of fillers to resin systems with poor initial hot strength substantially improves the hot strength. In the case of resins with good hot strength the addition of fillers yields little or no improvement.

Effect of heat aging

In many applications, not only must an adhesive retain good strength at elevated temperatures, but it must retain this strength over an extended period of time at that temperature. Fig 3 shows the effect of extended heat aging at 255 F on the shear strength of an epoxy adhesive, Araldite CN 503, both unfilled and filled, and a phenolic adhesive. After 60 weeks of heat aging, strength of the unfilled epoxy has dropped only slightly, while that of the filled epoxy has dropped about 10%. The phenolic ages very well for 24 weeks, but after 60 weeks it becomes badly embrittled and retains little strength.

The effect of various aging temperatures on an epoxy adhesive (Epon 828) cured with Shell Catalyst D is shown in Fig 4. The resin deteriorates gradually at 255 F and 284 F, but after 26 weeks still retains about two thirds of its original strength. At 320 F the decrease is more rapid, with a loss of about one half of its original shear strength after 8 weeks. Fig 4 also shows effect of heat aging on systems catalyzed with Catalyst A. After 26 weeks at 255 F, the strength is still slightly higher than the unaged strength. The initial increase in strength is probably due to increased cure.

TYPICAL STRENGTHS OF EPOXY BONDS[1]

Sample	Tensile Shear Strength, psi
Aluminum to Aluminum	3800
Steel to Steel	3100
Steel to Aluminum	3800
Copper to Copper	2000
Bronze to Bronze	3000

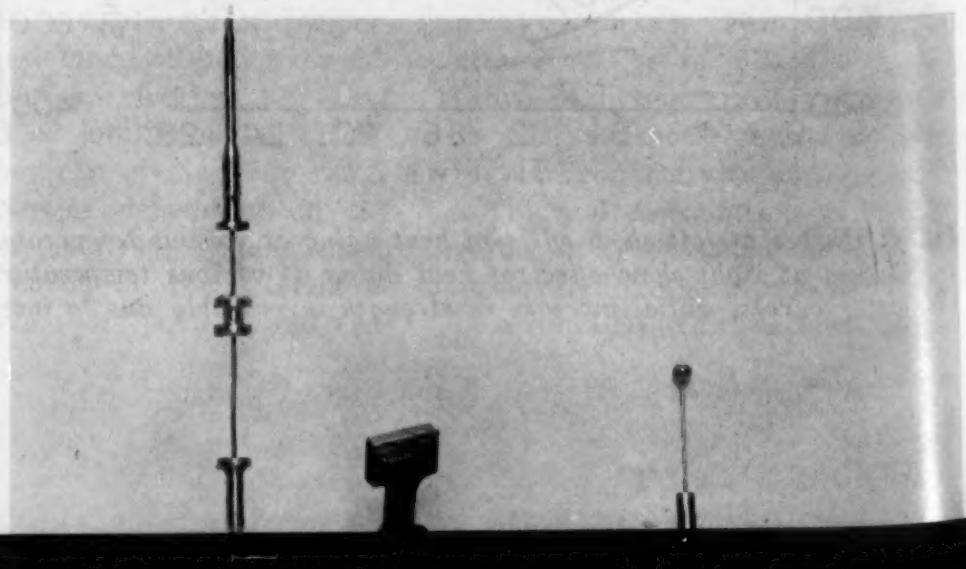
Resin used was Epon Adhesive VI. Source: Shell Chemical Corp., Bulletin SC 52-45R.

How Adhesives Are Tested

The most common method of measuring the strength of an adhesive is by determining shear strength. This is done by joining two pieces of sheet metal by a single lap joint. When tension is applied to the joint, the shear strength of the adhesive is the load required to cause failure, divided by the area of the lap. Since stress distribution at the joint is not uniform, shear strength varies with the length of the over-lap, and the thickness and type of metal. A 4:1 ratio of over-lap to metal thickness gives the best stress distribution.

Note: Based on a paper presented before Division of Paint, Plastics, and Printing Ink Chemistry, American Chemical Society Spring Meeting, April 1955.

***Joining dissimilar materials** is one of the prime advantages of adhesive bonding. The rod assembly at left is made of dissimilar metals, the rod being cemented to the end pieces and the center guide bonded to the rod. Close tolerances must be held. Second from left is a carbide rivet, resin-bonded to a magnesium arm. The vertical piston assembly contains a carbide rod bonded to a steel rod. And the horizontal magnesium rod has two carbide balls resin-bonded to its ends.*



Pressure Sensitive Tapes

by H. R. Clauser, *Editor, Materials & Methods*

Hundreds of pressure sensitive tapes are available for the great variety of uses they find in industry. This manual is designed to help you find the best ones for your particular needs.

The manual covers:

- *Paper Backed Tapes*
- *Cloth Backed Tapes*
- *Synthetic Film Tapes*
- *Laminated, Reinforced and Specialty Tapes*
- *Electrical Grade Tapes*

MATERIALS & METHODS MANUAL No. 125

This is another in a series of comprehensive articles on engineering materials. These sections provide the reader with useful data on characteristics and uses of materials, parts and finishes.

MARCH 1956

■ Today practically every field of industry is using pressure sensitive tapes in one way or another. Typical applications include masking, reinforcing, holding, insulating, edging, splicing, sealing, protecting, identifying, bundling, shielding, and joining.

To meet the specific requirements of the great variety of industrial applications, hundreds of different pressure sensitive tapes have been developed. While this manual could not possibly describe even a small portion of them, it can give a broad picture of the major types or groups available.

Selecting the proper tape for a specific job usually involves consideration of a number of tape properties. While it will be possible in many cases for you to narrow your choice down to a few types of tapes, it is generally advisable to work out the final choice with the help of tape suppliers. You can benefit from their experience. Also, if volume and other circumstances permit, a tape can be designed to fit your specific requirements.

The accompanying box lists the most important properties and characteristics of tapes. At least several of these must usually be considered when searching for a tape to meet your particular performance requirements.

What are pressure sensitive tapes?

Tape manufacturers have a very specific definition for the term "pressure sensitive". It is defined by the Pressure Sensitive Tape Council as follows:

"A term commonly used to designate a distinct category of adhesive tapes and adhesives which in dry (solvent free) form are aggressively and permanently tacky at room temperature and firmly adhere to a variety of dissimilar surfaces upon mere contact without the need of more than finger or hand pressure. They require no activation by water, solvent or heat in order to exert a strong adhesive holding force toward such materials as paper, cellophane, glass, wood and metals. They have a sufficiently cohesive and elastic nature so that, despite their aggressive tackiness, they can be handled with the fingers and removed from smooth surfaces without leaving a residue."

This definition specifically excludes tapes that are only sticky or merely cling to a surface such as protective sheets and frisket papers coated with latex or plain rubber. This article covers only the tapes that fall within the above definition.

Construction of tapes

Industrial pressure sensitive tapes are made up of two principal components—a backing and an adhesive. The nature of each component may vary over a wide range.

Backing—The backing can be any continuous material, such as paper, cloth, or plastics film, that will effectively hold the adhesive. Besides the basic function of carrying or supporting the pressure sensitive adhesive, the backing material must be flexible enough to be rolled and be strong enough not to fail as it is being unwound from the roll. Many service characteristics of the tape are dependent upon the backing material. Some of these are tear resistance, strength, toughness, conformability, color, printability and resistance to moisture, water, chemicals and weathering.

Present day tapes are constructed of any one of many different backing materials. Commonly used backings include impregnated paper, cotton cloth, glass cloth, acetate cloth, metal foils, and films such as cellophane, cellulose acetate, vinyls, polyethylene, polyester, and Teflon. When extra high strength is required, a number of these materials can be reinforced with glass, rayon or nylon filaments. Also, the backings can consist of laminations of two or more of these materials.

Backing materials are often treated in one or more ways to make the tape functional or to provide specific properties. These treatments include priming, sizing, impregnation, and coating with various compounds. Some of the benefits derived from the treatments include: 1) reduced adhesion of the adhesive to the backside and thus aid unwinding; 2) improved strength and other mechanical properties; 3) improved moisture, oil solvent or chemical resistance; 4) improved aging; 5) provision of special properties such as color, smoothness, gloss, printability.

Adhesive—The adhesive compound applied to the tape backing provides the tape with its ability to stick or hold to other materials. The adhesive must also have strong adhesion (anchorage) to its own backing so that the backing and adhesive will not separate (delaminate) either before or after being applied in service.

Another basic requirement of the adhesive is that it adhere to surfaces after very brief contact at finger pressure. This property is known as quick-stick or instant-adhesion. On the other hand, it should generally have reduced adhesion to the outside surface of the tape backing so that the tape can be easily unwound from the roll. Other basic requirements are that it must have sufficient internal strength to resist separation within the adhesive and lasting bond strength for the intended application.

Adhesives can be compounded to provide specific values of any of these properties. In general, the properties are closely interdependent, so that changing any one will affect some of the others. For example, adhesives that have high quick-stick often exhibit poor internal strength and shear resistance as well. The type and nature of tape backing also affects adhesive characteristics. Backing materials, such as cloth, with a rough adhesive surface have lower quick-stick values than tapes with smooth paper or plastics backings. On the other hand, with a rough backing such as cloth, the adhesive anchorage is benefited.

Besides the basic characteris-

tics just discussed, adhesives can be compounded to meet a variety of special service requirements. For example, high and/or low temperature performance can be provided for, through the use of certain specialized types of synthetic rubber adhesives.

Adhesives can also be formulated to prevent staining the surfaces on which they are to be used. Since staining can be caused by migration of substances from the adhesive into the paint or by migration of paint resins into the adhesive, the compounding of nonstaining adhesives is highly specialized and must often be tailored to the specific job. Like nonstaining adhesives, good resistance to oils, solvents, chemicals, and weathering must and can be obtained by special compounding.

Pressure sensitivity implies adhesive wetting which is responsible for increased adhesion with time or pressure. This factor along with softness of adhesives is responsible for two disadvantages when adhesives are not properly formulated: 1) the oozing or exudation of adhesive from the edges of the roll; 2) the increase of adhesion on porous surfaces to the point of adhesive transfer or removal.

Specific details about the types and composition of adhesives can not be given. Tape manufacturers are reluctant to disclose information on their own product formulations. Also the number of possible formulations is infinite and almost any desired property or combination of properties can be obtained.

Almost all adhesives used on pressure sensitive tapes are composed of a rubber or elastomer and a resin. The elastomer which provides internal strength and conformability, can be synthetic, crude or reclaimed rubber. The resin provides stickiness or adhesion to other surfaces.

Most adhesives are of the thermoplastic type. Their adhesive properties are generally best at around room temperature. They soften when heated and

Properties and Definitions

Adhesion

One of the most important and basic qualities all pressure sensitive tapes must have is the ability to adhere to the surfaces to which it is applied. A common and often misleading means of judging the adhesion is by the degree of stickiness of the adhesive as determined by the sense of touch. There are better and more accurate methods of measuring this property.

Peel adhesion is the most common method of measuring adhesion. It is defined as the force required to peel a strip of tape from a standard test panel and is expressed in ounces per inch width of tape. The test panel is usually a polished steel surface, and the tape is removed at the rate of 12 in. per minute.

Hold or shear adhesion is the ability of a tape to adhere under stress to a surface over a period of time. It is commonly measured in terms of time required to slide the tape, while under a definite load, from a standard flat surface. One standard test method (Pressure Sensitive Tape Council) involves measuring the time required for a 500 gm dead weight to slide a ½ in. long and 1 in. wide area of tape off a stainless steel test specimen.

Unwind adhesion is the bond which resists the force required to remove tape from the roll. It is usually expressed as the force in ounces per given width required to unroll the tape.

Quick-stick is the ability of the tape to adhere to a specific surface after a brief contact at low pressure. No tests standard throughout the trade has yet been established.

Strength

Tensile or breaking strength of tape is a measure of its ability to withstand stress. It is usually expressed in pounds per inch of width required to break a strip of tape. Because tape thicknesses are not taken into account in the tensile strength tests, the strength values for various types of tape are not directly comparable unless they are of equal thickness.

Tear strength

Often termed "tear resistance," this property usually refers to the resistance a tape offers to being torn crosswise (at right angles to the tape length). There are no standard tests for measuring tear strength. Tensile strength has often been used as an indication of tear strength, but there is seldom a correlation between them.

Conformability and elongation

The term "conformability," and sometimes "stretchability," is used to describe the ability of a tape to go around curves. Elongation is a rough indication of this ability; it is the amount of stretch measured at the point of break, expressed in percentage.

Moisture vapor transmission

This is an important property when tape is exposed to high humidity conditions. Moisture vapor transmission rate is expressed as the amount of moisture, in grams, transmitted through 100 sq in. of tape per 24 hr.

Water penetration

This is an important property when tape will have prolonged exposure to water. Water penetration rate is expressed as the grams of water penetrating 100 sq in. of tape per 24 hr.

Staining

This term refers to discoloration of surfaces by the tape. It is caused by a chemical reaction between ingredients in the surface finish and in the tape. Staining is accelerated by heat and high humidity and promoted by long application. Tapes must be tested in specific surfaces to determine their tendency to stain.

Aging

Aging is concerned with the ability of a tape to withstand the conditions commonly encountered in service—humidity, temperature and exposure to air —without deterioration, loss of adhesion and strength. Accelerated tests are generally used for evaluation.

harden to their previous condition upon cooling. Thermosetting or heat curing type adhesives are most commonly used in certain electrical grades. When heated at a specific temperature for a specific length of time, the adhesive firms and the heat and solvent resistance generally improves. Also adhesion to the surface after heat curing is increased rather than decreased.

The adhesive is applied to tape backings by either calendering or solvent spreading. In calendering, adhesive is applied at elevated temperature under pressure. The rubber and resin components are ground and mixed together to a smooth mass, then squeezed through rolls and applied to the backing. In solvent spreading, the adhesive mass is thinned with solvent. After the mass is applied to the backing material, the solvent is evaporated by passing the tape through an oven.

Paper Backed Tapes

Paper backed tapes are used more widely in industry than any other group of pressure sensitive tapes. The principal reasons for this is their suitability for paint masking and their relatively low cost. They (and the inexpensive grades of cloth tape) are first choice whenever they can meet the service requirements.

There are two basic types of paper tapes—crepe and flatback. As the names indicate, the former has the puckered, crinkly, rough appearance typical of crepe papers, and the latter has the flat, smooth appearance typical of brown wrapping paper. Paper backed tapes are available in almost any color and in thicknesses of from about 6 to 20 mils.

Kraft paper of various weights is used for crepe paper backed grades. The most common weight is 30 lb stock. Other weights up to around 70 lb are also used. Rope fiber paper is commonly used for flatback tapes (although kraft stock is used in the manufacture of a few grades).

Crepe paper tapes are generally not as strong as the flatback grades, but they have greater stretchability and, therefore, greater conformability. Flatback tapes are generally stiffer and have greater rigidity than creped tapes.

As a class, paper backed tapes are lower in strength and tear resistance than most other tapes. The low tear resistance, however, is an advantage in many cases where ease of tearing is desirable to speed-up dispensing and application of the tape. Crepe paper backed tape also has excellent conformability, one of the major reasons for its wide use for paint masking.

Within their range of usefulness, paper tapes are quite versatile, because paper backing can be treated in a wide variety of ways. In almost all cases, the paper backing is impregnated or saturated with an elastomeric compound to improve its strength characteristics. Flexibilty, tear strength, tensile strength and elongation are determined largely by the type of compound used. In addition, the outside surface is treated so that it will not permanently stick to the adhesive.

Besides these two basic treat-

PROPERTIES OF PAPER-BACKED TAPES

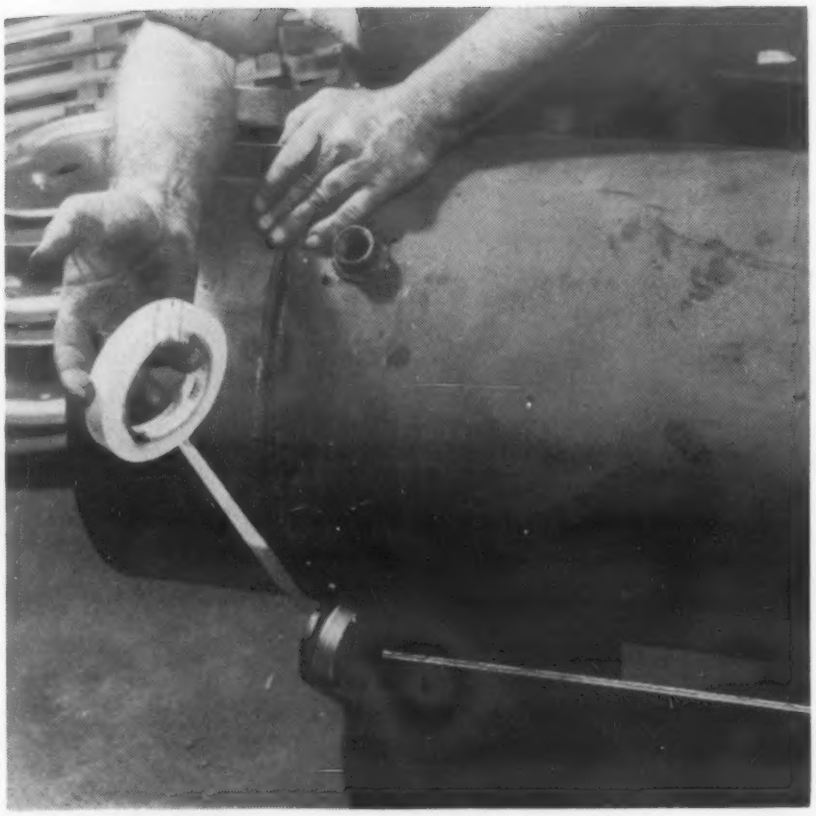
Backing	Thick, mils	Ten Strength, lb/in. width	Elong, % at break	Tear Resistance	Conformability	Adhesion to Steel, oz/in. width
Crepe—30 lb	7-10	15-20	10-15	Low	Excellent	20-40
Crepe—40 lb	9-11	25-30	8-12	Med	Excellent	20-30
Crepe—70 lb	20	40-55	30	Hi	Excellent	20-30
Flatback	6-8	25-30	5-7	Hi	Good	25-40
Flatback—High Strength	9-15	50-60	8	Hi	Good	25-35

The values in this table were compiled from many different sources. They are approximate and can vary widely depending on test used.

SOME REQUIREMENTS OF TAPES FOR SEALING AND PACKAGING
FEDERAL SPEC PPP-T-0060

Type	I		II	III	
Class	1	2 and 3	1	1	2 and 3
Unwind, lb/in. width	4	4	6.5	4	4
Tensile Strength, lb/in. (min)					
Dry	35	25	40	35	25
Wet	30	8	40	30	8
Water Vapor Transmission, gm/24 hr/100 sq in. (max)	1.0	1.0	5.0	—	—
Water Penetration, gm/24 hr/100 sq in. (max)	5.0	5.0	5.0	5.0	5.0
Holding Power, 1 x 1 in. (min) (Minutes except as indicated)					
As received:					
To steel	15	30	60	15	16 hr
To backing	3	25	3	3	3 hr
Aged:					
To steel	10	30	60	10	8 hr
To backing	2	15	2	2	3 hr
Adhesion, oz/in. width					
As received:					
73 F	25	25	25	25	25
32 F	19	19	19	19	19

Note-Refer to the specification for description of tests used.
Type I—Water vaporproof, waterproof, water resistant
Type II—Water vapor resistant, waterproof, water resistant
Type III—Waterproof, water resistant
Class 1—Exterior
Class 2—Interior, transparent
Class 3—Interior, colored



Tape with pressure sensitive *silicone adhesive seals a 48-in. seam where combustion chamber skirt joins the tank proper on a gas-fired hot water heater made by White Products Co. Surface temperatures range up to 520 F.*

Sealing access holes *in car door before applying upholstery facing. Crepe paper tape, 10 mils thick and 2 in. wide is used.*

Pressure sensitive tape *being used to join and seal joint in oval flue. Tapes are used in heating, air conditioning and ventilating systems.*

Sealing applications

Making permanent seal of joints of flexible connectors in air conditioning equipment
Sealing hot air duct joints in aircraft
Permanent sealing of seams
Can sealing spare parts
Sealing apertures
Cover openings of metal tubing
Sealing baking oven seams
Sealing fibre drums
Sealing containers of chemicals
Bag sealing
Sealing openings against dust, dirt, moisture and other foreign particles
Moisture barrier seals
Moisture seal—deep freezers
Making permanent seal of joints of flexible connectors

Photo credits: Dow Corning Corp.; Mystik Tape Co.; Minnesota Mining and Manufacturing Co.; Polyken Products; Behr-Manning Corp.

Cloth backed tapes *are widely used to seal exhaust and carburetor parts in aircraft engines to keep foreign matter out of moving parts during overhaul.*

ments, the backing can be treated to resist water, oils, solvents, heat and aging. Adhesives to meet many different service conditions can also be used. For example, by proper combination of adhesive and backing treatment, paper tapes have been developed to withstand temperatures as high as 350 F for up to 2 hr. General purpose paper tapes are useable up to about 200 F. Many paper backed tapes are available with stain resistant adhesives so that they can be used safely for masking or holding operations on light colored finishes.

Flatback paper tapes are also available in printable grades. They are made of color impregnated paper which has been treated to accept printing inks. These tapes find use for labeling, identification and packaging.

Cloth Backed Tapes

Cloth tapes include those with backings of either cotton fabric, glass cloth or acetate cloth. Cotton fabric grades are the most widely used.

There are two main types of cotton cloth tapes—plain or uncoated and coated. Both types are constructed of a woven cotton fabric backing and a rubber-base pressure sensitive adhesive. The coated type has the added feature of a plastics coating on the cloth backing. This coating is generally either polyethylene, vinyl or nitrocellulose applied by various methods depending on the quality and properties required.

Generally, the particular cotton fabric used in a tape is identified by its thread count. All other factors remaining constant, the larger the thread count, the stronger the tape. However, other factors, such as type and quality of cotton, size of individual fibers, and weave also greatly influence the strength and other properties. Cotton tapes are available in natural as well as a variety of colors. Thicknesses vary from around 10 to 20 mils.

Frequently cotton cloth tapes are broadly classified into economy (utility) and quality grades. The utility grades are lower in cost, and have medium tensile strength and relatively poor moisture and weather resistance. The quality grades are those which conform to Interim Federal Specification PPP-T-0060 (also Jan-P-127). These grades are more expensive, have higher strengths and meet the water vapor resistance and waterproof requirements of the specification.

The cotton backing for both plain and coated grades may be bleached to remove impurities for nonstaining and electrical applications. It can also be sized or chemically stiffened for greater ease of handling, dispensing and tearing. Priming is sometimes used to insure firm anchorage of adhesive, promote clean pull-off and eliminate lint transfer.

As a group, cotton cloth tapes have good toughness, tear resistance and conformability. The plastics coated grades have backings which are substantially waterproof and have fair to excellent resistance to oil and solvents. The uncoated grades have a small degree of moisture resistance due to the adhesive. Because of their wicking tendency, however, they are not usually satisfactory for waterproof applications. The coated grades also excel the plain cotton tapes in abrasion resistance and aging.

Although there are many uses where paper tape is adequate and the most economical, there are several differences that favor cotton tapes in many applications. Cotton tapes have more than twice the tensile strength of paper and cellophane. Most backings have more body and thicker adhesives which makes them more conformable to irregular shapes. In general, cloth tapes will remain stuck longer, pull off cleaner and age better.

Glass fiber cloth tapes were developed largely for high temperature and electrical applications. Some of them resist temperatures up to 450 F for long periods of time. Frequently thermosetting, flame-proof adhesives are used on glass fiber cloth tapes. These adhesives improve in holding strength with age and high temperature. Besides electrical uses, glass fiber tapes are used for such applications as sealing seams in ovens and in heating and air ducts, and for insulation of fiber sleeves on welding rod holders.

Acetate cloth tapes are used almost entirely in the electrical field and are, therefore, covered in the section on electrical tapes.

PROPERTIES OF CLOTH-BACKED TAPES

Backing	Thick Range, mils	Ten Str, lb/in. width	Elong, % at break	Tear Resistance	Conformability	Adhesion to Steel, oz/in. width	Moisture Vapor Trans Rate, gr/100 sq in./24 hr	Resistance to: Oil	Solvents	Heat—Used up to:	Aging
Plain Cotton	20	40-90	7-10	VG	G-VG	25-45	5-8	P	—	150 F	G to E
Cotton—Vinyl Coated	10-15	40-60	7-9	G	F	25-45	4-5	G to VG	G to VG	150 F	VG to E
Cotton—Polyethylene Coated	10-15	40-60	—	G	F	25-45	<1	G to VG	G to VG	150 F	E
Cotton—Nitrocellulose Coated	10-15	40-60	—	G	F	25-45	4-5	G to VG	G	150 F	G
Glass Fiber Cloth	6-8	140-200	3-5	VG	P	25-35	—	G to VG	G to VG	300 F	F
Acetate Cloth	7-9	40	12-20	F	F	25-40	—	—	—	125 F	G

The values in this table were compiled from many different sources. They are approximate and can vary widely depending on test used.

E—excellent
VG—very good
G—good
F—fair
P—poor

Insulation, joining, radio applications

Deaden sound, reduce vibration in aircraft
Air duct insulation
Anti-squeak insulation on cars
Silencer tape, metal-to-metal
Wrap insulation on pipes
Lagging tape over hair-felt insulation
Sound deadening in railroad cars
Silencing tape between lapped metal parts (felt backed)

Photo credits: Minnesota Mining and Manufacturing Co.

Aluminum foil tape *seals butt splices in insulation. Same tape is used as reflective covering against radiant heat and for stop-off masking during electroplating operations.*

Lead foil tape *serves as radio antenna inside plastic nose of helicopter.*

Sound damping tape, *made of aluminum foil, covers fuselage sections of airliners. It is also used in automotive industry and in light metal products where noise and vibration must be reduced.*

Synthetic Film Tapes

This group of pressure sensitive tapes includes those whose backings consist of a homogeneous synthetic or plastics film. In most cases the properties and characteristics of the tape are those of the film itself.

The oldest and most common synthetic film tape is cellophane. Although cellophane is still widely used, other synthetics have been rapidly adapted to tape construction to meet more severe or new service requirements. Those now in commercial use are cellulose acetate, vinyls, polyethylene, polyvinylidene chloride, polyester (Mylar) and Teflon.

As a group, plastics tapes have the following general characteristics: 1) high resistance to moisture, 2) various degrees of transparency and availability in a number of different colors, 3) retention of properties over wide temperature range, 4) high stretchability and conformability, 5) excellent resistance to oils, greases and solvents, 6) good resistance to wide range of chemicals, 7) good electrical insulation properties, 8) can be made in many different thicknesses.

The accompanying table lists specific properties of individual plastics backed tapes. Below are discussed some of the principal characteristics of each.

Cellophane

Cellophane was the first transparent synthetic film tape developed. Because of its moderate cost, it is still one of the most widely used, particularly in consumer fields. Cellophane tapes are produced in transparent or clear, colored and printed forms. As many as 16 different colors are available. The most common tape thickness is 3 mils.

Cellophane itself is resistant to grease, oil and solvents but the adhesive used in cellophane tapes may not be. Although cellophane film is not moisture proof, some resistance to moisture permeability is obtained from the rubber base adhesive. However, cellophane tapes are not normally recommended for uses where high humidity or moisture is encountered.

Cellophane tape is stronger than most crepe paper tapes but not as strong as many flatback paper and cloth tapes. Its tear resistance is relatively low. Although it has good conformability, it does not rate as high in this respect as crepe paper, cloth and vinyl tapes.

Cellulose acetate

Cellulose acetate backed tapes have many characteristics similar to cellophane tapes. They are grease, oil and solvent resistant and are available in transparent, colored or printed form. In addition, they have these advantages over cellophane: high resistance to water; substantial dimensional stability which minimizes the tendency of the backing to shrink away from the edges of the adhesive mass after application; and good weathering characteristics. They are generally more brittle than cellophane and about equal to it in strength.

Cellulose acetate tapes are higher in cost than cellophane. For this reason their uses are more specialized and limited to applications where their superior qualities are needed. Perhaps largest use is as a laminate over printed materials which require preservation against aging, moisture and exposure. Other uses include sealing, closures and light duty splicing.

Vinyl

Vinyl (polyvinyl chloride) tapes are produced in many grades, sizes and thicknesses to meet the conditions encountered in their three major fields of application—pipe wrapping, electrical insulation and general use. Their outstanding characteristics are high stretchability and conformability, flame resistance, abrasion resistance, and moisture and corrosion resistance.

Vinyl tapes for pipe wrapping range from 10 to 20 mils thick. The thicker grades are designed to provide maximum abrasion resistance, corrosion resistance and strength needed for heavy duty installations. The thinner grades are used where greater conformability is required, such as around valves and fittings.

Thin vinyl tapes, around 5 mils thick, are available in many different colors. Because of their

PROPERTIES OF SYNTHETIC FILM BACKED TAPES

Backing	Thick Range, mils	Ten Str, lb/in. width	Elong, % at break	Tear Resistance	Conformability	Adhesion to Steel, oz/in. width	Moisture Vapor Trans Rate, gr/100 sq in./24 hr	Resistance to: Oil	Solvents	Heat—up to:	Cold—down to:	Aging
Cellophane	3-4	25-30	15	G	F	28-35	—	E	E	200-300F	0 F	G
Cellulose Acetate Film	2-3	15-30	10	F	F	30-35	—	VG	G	250 F	0 F	E
Polyvinyl Chloride	6-20	20-60	150-300	VG	E	30-40	<1.5	G	G	200 F	0 F	E
Polyethylene	7-20	13-45	60-130	VG	VG	30-50	<1.0	VG	E	200 F	0 F	E
Polyvinylidine-Chloride (Saran)	3	25-30	100	VG	VG	50	<0.5	G	G	200 F	—10 F	G
Polyester (Mylar)	2-2½	20-30	50-100	VG	F	38	1.5 to 2.0	E	E	300 F	0 F	E
Polytetrafluoroethylene (Teflon)	6	15	300	E	G	25	0.0 to 0.5	E	E	500 F	—65 F	E

The values in this table were compiled from many different sources. They are only approximate and can vary widely depending on test used.

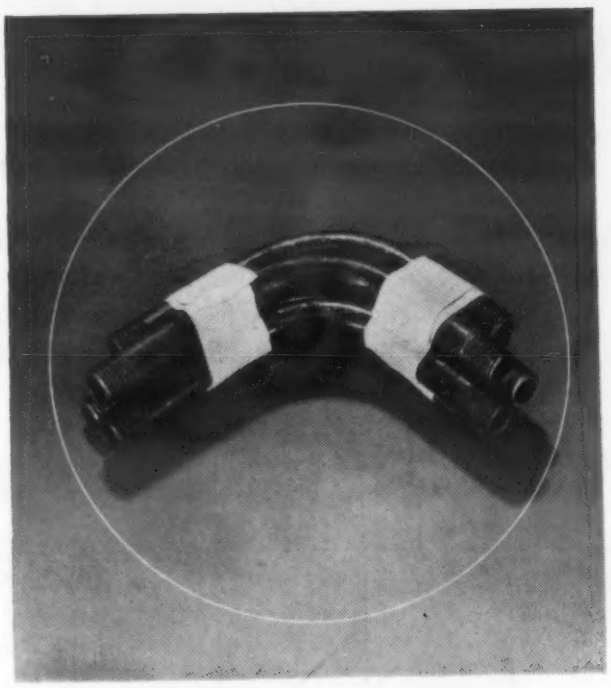
E—excellent
VG—very good
G—good
F—fair

Pressure sensitive tapes *are widely used for harness wraps. Tape is applied manually or with automatic taping machine.*

Holding and splicing applications

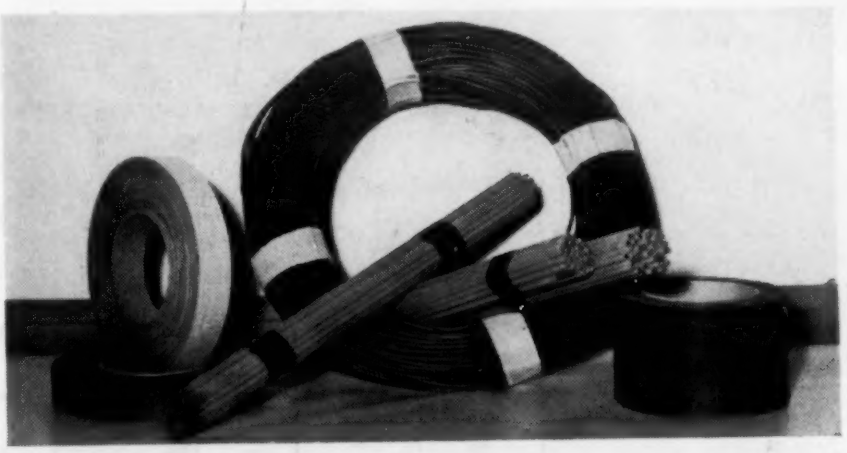
Holding foam rubber cushions to seat frames
Holding doors closed on various products during shipment
Bundling of all kinds
Taping mirrors in luggage, pocketbooks
Wire harnesses in many different products and equipment
Holding leads in place in coil winding
Securing cotton filter material to metal core on diesel air filters
Holding wires in place in electrical coils
Binding insulating materials together in motors, generators and transformers
Holding gaskets in place
Holding stacked steel sheets together
Holding strap to TV picture tube
Splicing sponge rubber
Carpet underlay splicing
Butt splice of auto upholstery
Splicing imitation leather
Wire splicing of many kinds
Splicing plastic coated wires
Electrical maintenance splicing
Cable splicing kits

Photo credits: Polyken Products; Hampton Manufacturing Co.; Minnesota Mining and Manufacturing Co.



Tapes are adaptable *to many different bundle applications. Here pieces of formed pipe are held firmly together for shipment.*

Plastic tape *being dispensed by a taping gun to spot-tape an electric harness in an electrical device.*



Cotton cloth *backed tapes hold coil of wire and bundles of welding electrodes.*

high resistance to abrasion, they find wide use for edging and floor marking. Other general applications are sealing, labeling and identification.

Polyethylene

Polyethylene tapes have many characteristics similar to the vinyl grades. They have excellent resistance to moisture and to a wide variety of chemicals, but they are not as strong or abrasion resistant, as the vinyls. They have excellent cold temperature flexibility and are extremely stable from the standpoint of shelf aging and service life. Polyethylene tapes had been used successfully for reinforcing seams and weak points in stratospheric balloons. They are also used for protecting pipe lines above and below ground.

Polyester

The unusually good mechanical, physical and electrical properties of polyester (Mylar) films make them an attractive tape backing material. Although high in cost, polyester tapes are finding increasing use in the electrical field and specialized nonelectrical applications such as durable striping and identification.

Polyester film is transparent, but colored tapes can be made by adding pigments to the adhesive. They are two to three times as strong as cellophane and cellulose acetate, have higher tear resistance and greater conformability. Because of the material's extra high strength, very thin tapes are possible. These thin tapes are particularly advantageous for use on parts or products where build-up is undesirable.

Polyester tapes are generally useful over the temperature range of −25 to 225 F. They resist attack by oils, greases, acids, alkalies and solvents. The high electrical insulation values over a wide temperature range suit them for many electrical uses.

Teflon

Teflon backed tapes, because of their high cost, are limited, as are Mylar tapes, to specialized applications. Teflon's outstanding characteristic is its excellent heat resistance. Depending on the adhesive mass, Teflon tapes are useful at temperatures up to 500 F and as low as −65 F. Like Mylar, Teflon tapes are highly chemical resistant and have excellent electrical properties.

Reinforced, Laminated and Specialty Tapes

Reinforced and laminated pressure sensitive tapes have backings constructed of more than one material. By using various combinations of backing materials or by adding filaments, special properties not possible with a single film or material can be obtained.

PROPERTIES OF REINFORCED TAPES

	Thick Range, mils	Ten Str, lb/in. width	Elong, % at break	Impact Str, in.-lb/in. width	Adhesion to Steel, oz/in. width
Cellulose Acetate Fibre	6-7	30-38	5	—	27-36
Cellulose Acetate—Rayon Reinforced	10	200	15	150	70
Cellulose Acetate—Glass Reinforced	8-9	325-500	3	225	70
Paper—Glass Reinforced	13-15	240	3-5	75	38-60
Vinyl—Glass Reinforced	10	500	3	250	70
Polyethylene—Glass Reinforced	6-12	130-140	3	100	50
Polyvinylidene Chloride—Glass Reinforced	7	65	3	—	—
Mylar—Rayon Reinforced	8	200	14	—	—
Nylon Reinforced	7	80-90	20	—	—

The values in this table were compiled from many different sources. They are approximate and can vary widely depending on test used.

REQUIREMENTS OF FILAMENT REINFORCED TAPES
FEDERAL SPEC PPP-T-97A

Type	Resistance to impact, in. lb/in. width		Tensile, lb/in. width	Elongation, %	
	For single drop	For 25 drops		Min	Max
Low Tensile Strength (Type I)	60	30	160	9	20
Medium Tensile Strength (Type II)	40	20	240	3	8
High Tensile Strength (Type III)	80	40	475	3	8

Note: Refer to the specification for description of tests used.

Reinforced tapes

Reinforced tapes are constructed of a conventional backing material with parallel strands of reinforcing filaments or fibers laminated to the backing. The pressure sensitive adhesive is placed over this reinforcing lamination. The reinforcement runs lengthwise in the tape. All backing materials discussed in previous sections, except cloth and cellophane, are available as reinforced tapes.

The reinforcing filaments most commonly used are glass fibers, rayon and nylon. Some of the most widely used reinforced tapes are cellulose acetate backing with rayon or glass filament reinforcement which provides a high strength, highly water resistant tape; a paper backing with glass filament reinforcement which provides a high strength but a relatively low cost tape; and vinyl, polyethylene or Mylar backing with glass filament reinforcement which provides high corrosion and moisture resistance combined with high strength.

As is evident from the above remarks and a study of the accompanying table, the principal advantages of reinforced tapes

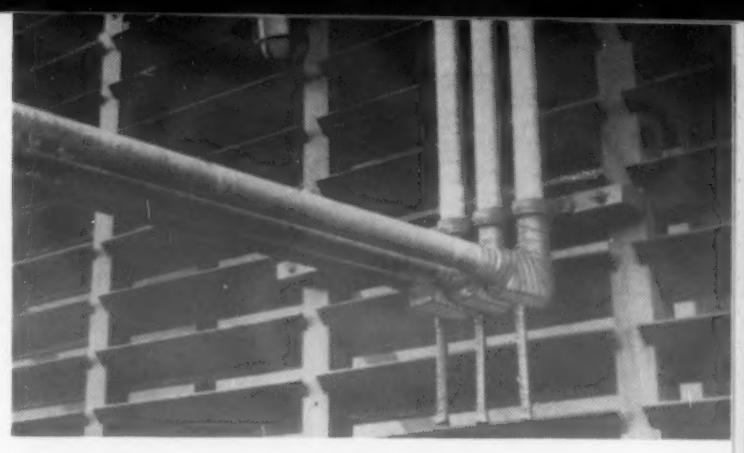
Protecting applications

Protecting polished metal surfaces during fabrication — stainless steel, aluminum, brass, etc.
Protecting finished parts during fabrication and assembly
Aircraft fuel tank edge liner protection
Protecting cutting edges on tools
Protecting threaded ends of pipes, rods
Protecting precision surfaces
Separation of dissimilar metals to prevent galvanic corrosion
Outside cable protective wrapping
Protection of electric wiring at hot spots in appliances
Covering electrical cables in elevator shafts to protect against abrasion
Waterproof covering over pipe insulation
Taping pump jackets
On rubber molded auto window section for abrasion resistance
Edging of sheet materials and glass
Cushioning between sheet metal
Protecting battery cables from acid corrosion
Pipe wrapping to protect from corrosion

Identifying applications

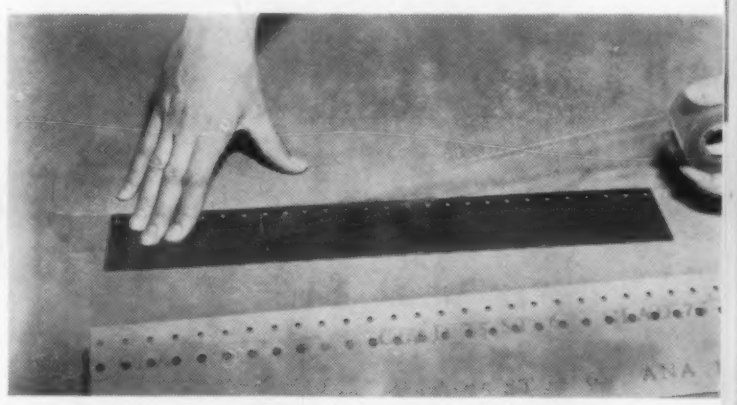
Color coding fuel, oil and hydraulic lines in aircraft
Marking parts bins
Labels on transformers
Printed instructions
Utility marking
Stock identification
Identification markings on aircraft
Identifying grades of materials
Identifying parts for assembly
Identifying pipe lines
Identifying fittings
Decorative trim

Photo credits: Polyken Products; Minnesota Mining and Manufacturing Co.



***Polyvinyl chloride** and polyethylene backed tapes used for pipe wrapping offer resistance to galvanic, water and chemical corrosion.*

***Thin pressure sensitive** paper tape protects stainless steel during fabrication. Use of protective tape significantly cuts damage losses.*



***Plastic tape** is used to separate dissimilar metals in aircraft structures thus eliminating tendency for galvanic corrosion.*

***Yellow plastic tape** is permanently stamped into the face of an aluminum door handle. Excess tape is easily stripped off leaving the recessed letters in the finished handle.*

are high strength and toughness. Not only do they have strengths four to ten times that of plain backed tapes, but their resistance to shock loading or impact is many times greater than non-reinforced tapes. These advantages are gained with little or no increase in thickness and with only a relatively small increase in cost.

Laminated tapes

Laminated tapes are made up of two or more backing materials laminated together. With one exception, these tapes are relatively new and highly specialized. Almost any combination of materials could be used as backings. But most of the laminated tapes now available were developed to meet specific needs. Others are being developed as the need arises.

The oldest and still most common laminated tape is acetate fibre, composed of cellulose acetate film laminated to rope fibre paper. The acetate film forms the outside surface of the backing, and the paper is adjacent to and holds the pressure sensitive adhesive. Both the acetate film and the paper are usually very thin, running about 0.00088 in. and 0.002 in., respectively. They are laminated together with a moisture proof, pressure sensitive adhesive. Acetate fibre tapes are also available in a variety of colors. Certain types conform to Federal Specification PPP-T-0060 (formerly Jan P-127).

The principal qualities of acetate fibre tapes are high strength, high dimensional stability, high resistance to water vapor and good printability. The fact that these characteristics are available in a relatively thin tape (up to 6.5 mils thick) is an added advantage.

Some of the common uses of these tapes are for moisture proof sealing of containers and edging rigid materials. A major use of colored and white grades is as printed tape for identification of wires, tubes and pipes and for instruction or brand labeling of finished products, such as electrical fixtures, auto parts and tools.

A few of the other available laminated pressure sensitive tapes are briefly described below:

Cloth and aluminum foil. Developed primarily for use on inside of fuselage skin in commercial aircraft. It has good sound dampening properties combined with high fire resistance. It also provides thermal insulation, is 100% waterproof and has excellent weather resistance. Besides aircraft, the tape is used on automobile firewalls, hoods, door panels and trunk lids, and to reduce sound transmission through housings on food processing equipment.

Mylar and metal foil. Used for identifying tubes containing solvents destructive to all other types of pressure sensitive tapes.

Cellophane riveters tape. Constructed of clear cellophane with a center strip narrower than the tape, laminated to adhesive side of tape to provide a nonsticky surface. Use for prepositioning rivets during fabrication of metal products.

Double faced tapes

The distinguishing characteristic of double faced tapes is that their backing has a pressure sensitive adhesive on both sides. Cloth, paper and cellophane are the most commonly used backing materials. To prevent the adhesive faces from sticking together in the roll, a removable interliner is used on one or both sides of the tape. After the tape is unrolled for use, the interliner is discarded. A recent adhesive development has eliminated the need for the liner on certain tapes.

Perhaps the largest field of application of double faced tapes is as an adhesive in non-liquid or non-paste form. For many uses they have proved superior to liquid and paste adhesives by eliminating the need for brushes, solvents or drying ovens. Another advantage is that materials fastened together with double faced tapes can be taken apart if necessary and rejoined again.

Double faced tapes are available with many different adhesive characteristics, in many different sizes and thicknesses. They can be used to join together (back-to-back) almost any two dissimilar materials—metal to rubber, paper to metal, rubber to cloth, wood to metal, metal to plastics, etc. Some typical uses of these tapes are holding foam rubber cushions to seat frames in aircraft, fastening carpeting to floors, insulating between dissimilar metals to prevent galvanic corrosion, and securing felt pads to underside of telephones and lamps.

Metal foil tapes

Metal foil tapes are still relatively new. Copper, aluminum and lead are the principal metals now being used. A typical aluminum foil tape is about 5 mils thick and is coated with a high-tack thermosetting type adhesive. Its average property values include tensile strength of 32 lb per in. of tape width; elongation of 15% at breaking point; adhesion of 60 oz per in. of tape width; and, a moisture-vapor transmission rate of 0.1gm per 100 sq in. per 24 hr at 100 F.

Aluminum tapes are unaffected by extreme humidity conditions and feature excellent heat reflection, weathering, moisture resistance, and conductivity characteristics. They are used for sealing splicing, conduction and heat reflection. Aluminum tape is also used as a stop-off in electroplating and in the electrical and electronic industries as reflective heat shielding, interference shielding and protective covering on cable splices. Other uses are sealing overlap joints of metal sheets and weatherproofing and permanent masking on neon lights.

Lead foil tapes are similar to aluminum tapes in their excellent resistance to moisture and weathering. Besides many sealing applications, lead tape is currently being used for radio antennas in helicopters. The tape adheres permanently to the plastics nose of the aircraft despite all the types of natural weathering conditions encountered in service.

Copper foil tapes cannot be classed as pressure sensitive un-

Masking applications

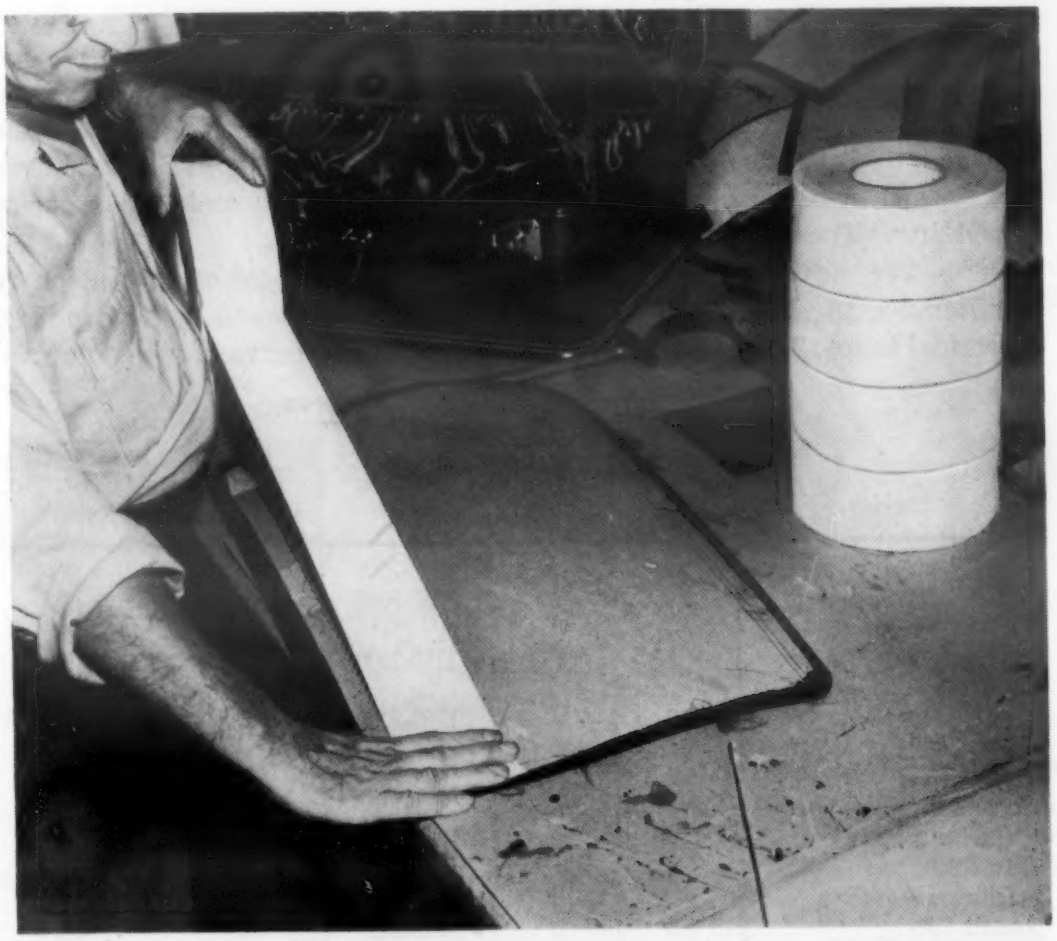
Masking for shot peening
Paint masking
Electroplating stop-off masking
Masking or block-off during chromizing operations
Sand blast masking
Masking openings during spray cleaning
Masking coils through varnish dip and bake-out of moisture
Masking surfaces during buffing and polishing operations
Masking parts or components during spray painting
Silk screen stop-off
Masking electrical circuits

Curved masking jobs *are best handled with crepe paper tapes because of their good conformability.*

Reinforcing applications

Reinforcing baseball mitts
Reinforcing seams in car upholstery
Corner reinforcement in luggage
Reinforcing stitches on canvas, plastic and leather bags
Reinforcing corrugated boxes
Reinforcing seams and eyelets in shoes
Glove reinforcement
Reinforcing seams on unsupported plastic sheets in upholstery work
Edging and reinforcing seams in wallets
Package reinforcing
Reinforcing paper, leather and textile products

Photo credits: Minnesota Mining and Manufacturing Co.; Permacel Tape Corp.



High strength cotton *cloth tape provides reinforcement on luggage. Tape replaces glued strips and gives longer life.*

der the definition given at the beginning of this manual. They require either solvent activation or heat and pressure to produce the required bind. Copper foil tapes of this type can be bonded to phenolic board, steel, brass, bronze, aluminum, wood and other materials. They are widely used in printed circuit production, punched circuit laminations and as decorative laminates.

Electrical Tapes

Most of the types of tape covered in the preceding sections are used as pressure sensitive electrical tapes. However, they are produced as a separate and distinct line to meet the special service requirements of the electrical industry. These requirements are: 1) good electrical properties, including high electrical insulation values and dielectric strengths; 2) noncorrosive to wires or parts on which used; 3) resist action of certain solvents; and 4) retain properties at elevated temperatures.

To meet these requirements, the backings for electrical tapes are special grade materials purified to contain only a minimum of the soluble salts which might permit electrolytic corrosion. The adhesives must also be a special grade and must not contain such elements as sulfur since they also would cause chemical corrosion.

Two general types of adhesives are used—thermoplastic and thermosetting. The thermoplastic adhesives are similar in action and perfomance to those used in non-electrical tapes. The thermosetting adhesives harden or set under heat and are used where the thermoplastic types are unsuitable due to high temperature or solvent action.

Electrical properties

The two principal electrical properties that must be considered in evaluating pressure sensitive tapes are ability to insulate and to withstand the imposed voltages.

Insulation resistance — Insulation resistance is measured by the resistance a tape offers to the flow of current and is expressed in megohms. For an accurate comparison, the insulation values of various tapes must be obtained under the test conditions (particularly relative humidity) described in ASTM D-1000-53T. As the accompanying table shows, polyester and Teflon film tapes have the highest insulation values. Next highest are the acetate film and acetate cloth grades, followed by cotton cloth and paper backed tapes.

The reciprocal of insulation resistance is known as the indirect electrolytic corrosion current value. This value is given in micro-microhms and is used as a measure of the tendency of a tape to deteriorate due to electrolytic corrosion of copper. The lower the value, the less the tendency for corrosion. It should be obvious that tapes with the highest insulation resistance also have the least tendency to electrolytic corrosion.

Dielectric strength — Dielectric strength indicates the ability of a tape to withstand high voltages without breaking down. All of the film backed tapes have high dielectric strengths. Of these, Mylar and Teflon tapes are the highest. Where high voltages are not involved, paper and cloth tapes perform satisfactorily.

High temperature resistance

All insulation materials fall into one of several established classes, depending upon their heat resistance. These insulation classes, in order of increasing temperature resistance, are O, A, B, H and C.

Most electrical grades of pressure sensitive tapes qualify as Class A insulation. Paper, cotton cloth, acetate cloth, acetate film and laminated tapes fall into this category. Glass cloth tapes with rubber adhesives are rated as Class B insulation. Polyester (Mylar) tapes are classed as B and sometimes A. Glass tapes and Teflon tapes with silicone adhesives are classified as Class H insulation.

Electrical tapes may encounter high temperatures not only in service, but also during the manufacture of components of which they are a part. This most frequently occurs when electrical units undergo a baking operation to expel moisture. The baking cycles vary in temperature from about 180 F to 300 F and in time from ½ hr to 18 hr.

Thermosetting or heat curing type adhesives are used on these tapes. Thus, the holding power is increased rather than decreased by the baking cycle. These same

PROPERTIES OF ELECTRICAL TAPES

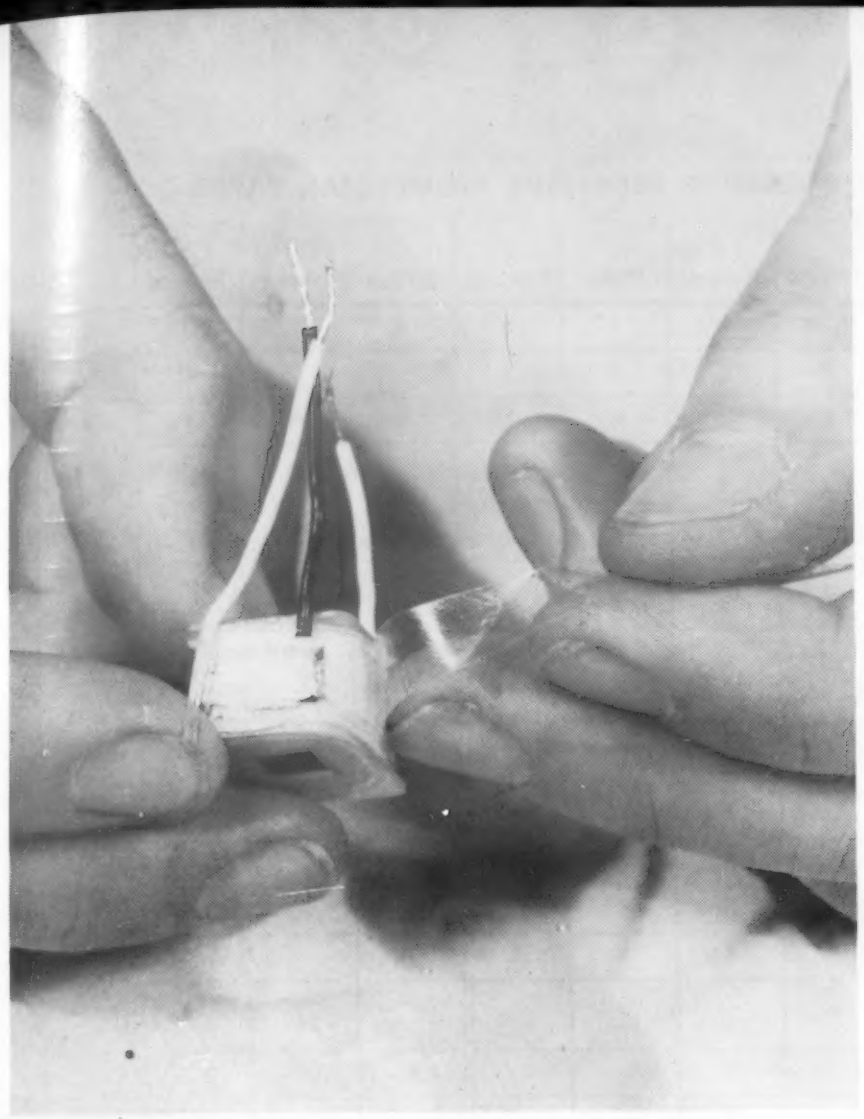
Backing	Thickness, mils	Class of Insulation[1]	Dielectric Strength, volts	Insulation Resistance[2]	Indirect Electrolytic Corrosion[2]
Crepe Paper—Yellow	10	A	1250-2000	(7)	(7)
Crepe Paper—Black	10	A	1250-2000	(7)	(7)
Flatback Paper—Yellow (4 mil rope)	7	A	1250-2000	(7)	(7)
Flatback Paper—Black (4 mil rope)	7	A	1250-2000	(7)	(7)
Cotton Cloth	11	A or O	1500-2500	(6)	(6)
Acetate Cloth	9	A or O	1800-2500	(3)	(3)
Glass Cloth (rubber adhesive)	7	B	1500-3000	(4)	(4)
Glass Cloth (silicone adhesive)	—	H	1500-3000	(4)	(4)
Acetate Film	3.5	A	5000-6000	(2)	(2)
Polyester Film (Mylar)	2.5-3.5	A or B	5500-8000	(1)	(1)
Acetate Fibre	10	A	5000	(5)	(5)
Acetate Film—Acetate Cloth	9.5	A or O	5500-7000	(3)	(3)
Teflon (silicone adhesive)	—	B & H	5000-9000	(1)	(1)

The values in this table were compiled from many different sources and are only approximate ranges. Test results vary widely depending upon test conditions.

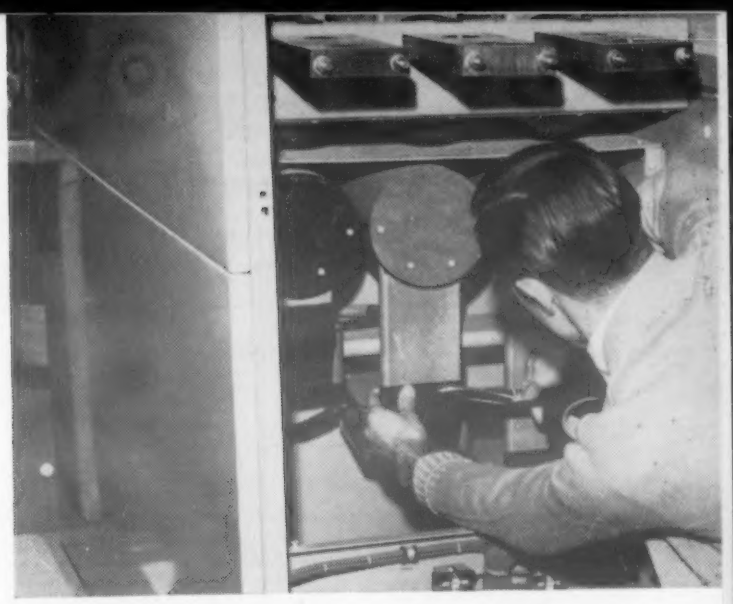
[1] *Classes of Insulation:*

	Limiting Temp, C ("Hottest-Spot")	*Limiting Rise, C*
Class O	*90 (194 F)*	*50 (122 F)*
Class A	*105 (221 F)*	*65 (149 F)*
Class B	*130 (266 F)*	*90 (194 F)*
Class H	*180 (356 F)*	*140 (284 F)*

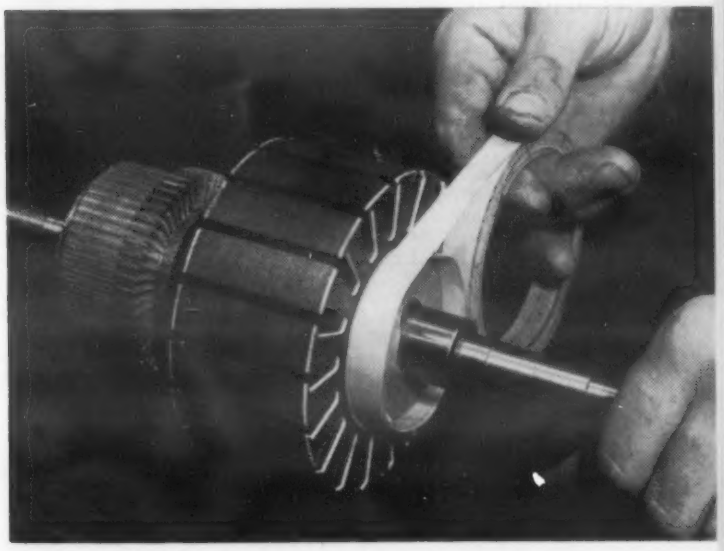
[2] *(1) = Highest insulation resistance and electrolytic corrosion resistance.*
(7) = Lowest insulation resistance and electrolytic corrosion resistance.



Polyester backed *electrical tape, only 3 mils thick, is designed for use in fine wire coils, transformers, and in miniature electric components.*



Electrical grade tape *used in the insulation of silver plated copper bus bars in a 5000 v switchgear. A flexible tape with high dielectric strength is required.*



Yellow flatback *paper tape holds paper disk in place and insulates core from coil windings in this electric motor rotor unit.*

Electrical applications

Cuffing slot insulators on turbines
Coil winding and wrap around outer surface after winding
Insulation on lead ends
Insulation around base of aerials on commercial aircraft
Insulation in radio and radar equipment
Holding wires in place in electrical coils
Slot insulation
Wire wrapping on fractional and large horsepower motors
Cable wrap on turbines
Holding and binding insulating materials in electrical apparatus

Photo credits: Minnesota Mining and Manufacturing Co.; Permacel Tape Corp.

resins added to the adhesives to improve holding power after curing also develop resistance to solvents, such as naptha, which are commonly used in electrical varnishing.

Other properties

In addition to the electrical and special requirements listed above, electrical tapes must have some or all of the properties of standard nonelectrical grades, such as tensile strength, tear resistance, conformability, and moisture resistance. In many applications they must also have good abrasion resistance. In some cases tape thickness is a consideration. Sometimes the thinnest possible tape is needed where there is a minimum of space while at other times, bulk is required.

Applications

The most common applications of electrical pressure sensitive tapes include insulation for electric motors, coils, cores and transformers; electrical harness wrapping or spot taping; holding down or securing lead wires; splicing and insulating wires in toasters and stoves; and for insulating wire and cable splices, bus bars and stress cones; for splicing lead wire connections, and making strapping pads in wire relay coils and solenoids.

COMMERCIAL SOURCES OF PRESSURE SENSITIVE INDUSTRIAL TAPES

Type Tape ↓ / Manufacturers →	Arno	Behr-Manning	Continental	Hampton	Minnesota	Mystik	Permacel	Polyken	Seamless	Technical	Johns-Manville	U. S. Rubber
Paper, Crepe	X	X	X	X	X	X	X	X	X	X	X	X
Paper, Flatback	X	X	X	X	X	X	X			X	X	X
Cotton, Uncoated	X	X		X	X	X	X	X	X	X	X	X
Cotton, Uncoated Drill Cloth	X				X			X			X	X
Cotton, Vinyl Coated	X			X		X	X	X	X	X		X
Cotton, Polyethylene Coated	X			X		X	X	X	X	X	X	X
Cotton, Nitrocellulose Coated							X	X	X	X	X	
Acetate Cloth					X		X	X	X	X		
Glass Cloth					X	X	X	X		X	X	
Cellophane					X		X			X		
Cellulose Acetate Film					X		X			X		
Polyvinyl Chloride		X			X	X		X		X	X	X
Other Vinyls					X	X	X					X
Polyvinylidene Chloride (Saran)					X							
Polyethylene					X			X	X			
Polyester (Mylar)					X	X				X		
*Polytetrafluoroethylene (Teflon)					X							
Cellulose Acetate Fibre					X		X					
Cellulose Acetate, Rayon Reinforced					X		X			X		
Cellulose Acetate, Glass Reinforced					X					X		
Paper, Glass Reinforced	X	X	X	X	X	X	X		X	X		X
Vinyl, Glass Reinforced					X						X	
Polyethylene, Glass Reinforced					X							
Polyester, Rayon Reinforced					X							
Polyester, Nylon Reinforced					X							
Cloth-Aluminum Foil							X					X
Polyester-Metal Foil					X	X						
Copper Foil							X					
Aluminum Foil					X	X	X					
Lead Foil					X	X						
Double-Faced, Cloth	X				X		X	X			X	
Double-Faced, Paper					X	X	X			X	X	
Double-Faced, Cellophane					X		X					
Electrical Grades	X	X			X	X	X	X	X	X	X	

Arno Adhesive Tapes, Inc. — *East 6th and Tommas St., Michigan City, Ind.*
Behr-Manning Corp. — *Troy, N. Y.*
Continental Tapes — *Cayce, South Carolina*
Hampton Manufacturing Co. — *111 Cedar Street, New Rochelle, N. Y.*
Minnesota Mining & Mfg. Co. — *900 Fauquier Avenue, St. Paul 6, Minn.*
Mystik Adhesive Products — *2635 North Kildare Avenue, Chicago 39, Ill.*
Permacel Tape Corp. — *New Brunswick, N. J.*
Polyken Products Dept., Kendall Co. — *222 West Adams Street, Chicago 6, Ill.*
The Seamless Rubber Co. — *261 Hallock Avenue, New Haven 3, Conn.*
Technical Tape Corp. — *177th Street & Harlem River Drive, N. Y., N. Y.*
Johns-Manville, Dutch Brand Div. — *7800 South Woodlawn, Chicago 19, Ill.*
United States Rubber Co. — *Rockefeller Center, New York 20, N. Y.*

** U. S. Gasket Co., Camden, N. J., also supplies Teflon tape.*

Acknowledgements

The following organizations, through their literature and personal help, supplied much of the information for this manual.

Permacel Tape Corp.
Hampton Manufacturing Co., Industrial Tape Div.
Pressure Sensitive Tape Council
Industrial Tape Div., The Seamless Rubber Co.
Polyken Products, Department of the Kendall Co.
Minnesota Mining & Manufacturing Co.
Behr-Manning Corp.
Cover Photo: Permacel Tape Corp.

MATERIALS ENGINEERING FILE FACTS

Properties of Gray Iron—A Material Data Sheet

Gray iron castings are usually specified by tensile strength leaving the chemistry within certain limits to the producer. Classes 20, 25 and 30 cover the ordinary grades of gray cast iron. Classes 35, 40, 50 and 60 are considered high strength irons particularly in medium or heavy sections.

Type ASTM A48-48 Class		20	25	30
Specified minimum tensile strength, psi		20,000	25,000	30,000
Physical Properties				
Density, lb/cu in.		0.26	0.26	0.26
Thermal Cond Btu/hr/sq ft/ft/F, at 212F		24-34	24-34	24-34
Coef of Exp per F 32-212F		6×10^{-6}	6×10^{-6}	6×10^{-6}
Elect Res, microhm-cm at 68F		Varies from 50 to 200 depending on composition		
Magnetic Properties		Magnetic		
Mechanical Properties Mod of Elast in Tension[1], psi	a	13×10^6	14×10^6	16×10^6
	b	12×10^6	13×10^6	15×10^6
	c	9×10^6	11.5×10^6	13.5×10^6
Tensile Str, 1000 psi As cast	a	24-29	27-33	35-40
	b	20-24	25-30	30-34
	c	15-19	20-24	20-24
Transverse Str 1000 lb, As cast	a[2]	1	1.25	1.4
	b[3]	2	2.1	2.2
	c[4]	5.2	5.5	7.3
Deflection in., As cast	a[2]	0.14	0.17	0.16
	b[3]	0.25	0.27	0.28
	c[4]	0.25	0.30	0.31
Mod of Rupture 1000 psi As cast	a	50	57	63
	b	53	56	58
	c	40	42	56
Hardness[5], Bhn As cast	a	200	205	210
	b	180	190	200
	c	170	175	180
Fatigue Str[6] (End Limit), 1000 psi As cast	b	10	12.5	14.5
Compressive Str[7], 1000 psi As cast	a	100		
	b	95	100	115
	c	90		
Shear Str, 1000 psi As cast	b	32	37	44
Fabricating Propeties Machinability Index AISI B1112=100		Gray cast iron having a ferrite matrix, in which graphite flakes are dispersed, has a machinability rating of 110. When a cast iron microstructure shows alloy segregation, free carbides, steadite and free pearlite, machinability is reduced and may be as low as 40. Some castings show several structures due to cooling rate and section size.		
Joining		Can be joined by gas welding, shielded metal-arc welding using special electrodes, carbon arc welding. Preheating necessary. Can be brazed with nonferrous filler metal.		
Corrosion Resistance		More resistant to some types of corrosion than carbon and low alloy steels possibly because of graphite; cast iron soil pipe usually lasts longer than steel pipe, for example. Gray irons are resistant to strong sulfuric acid, cold concentrated phosphoric and nitric acids, attacked by dilute sulfuric, phosphoric and nitric. Resistant to many alkalies including sodium hydroxide, soda ash and ammonia.		
Typical Uses		Machine bases; grates, housings, ornamental castings, sanitary wear, piston rings, pipe and fittings.	Similar to class 20 where higher strength is required.	Light brake drums, clutch plates, cylinder blocks, liners, impellers, pipe and fittings, grate bars, machine components.

MATERIALS ENGINEERING FILE FACTS

PROPERTIES OF GRAY IRON—continued

Type ASTM A48-48 Class		35	40	50	60
Specified minimum tensile strength psi		35,000	40,000	50,000	60,000
Physical Properties					
Density, lb/cu in.		0.26	0.26	0.26	0.26
Thermal Cond Btu/hr/sq ft/ft/F, at 212F		24-34	24-34	24-34	24-34
Coef of Exp per F 32-212F		6×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}
Elect Res, microhm-cm at 68F		Varies from 50 to 200 depending on composition			
Magnetic Properties		Magnetic			
Mechanical Properties Mod of Elast in Tension[1], psi	a	17×10^6	18×10^6	19×10^6	20×10^6
	b	16×10^6	17×10^6	19×10^6	19.5×10^6
	c	14.5×10^6	15.5×10^6	18×10^6	19×10^6
Tensile Str, 1000 psi As cast	a	38-42	50	60	70
	b	35-40	40-48	50-57	60-66
	c	25-33	33-45	52	50-75
Transverse Str 1000 lb, As cast	a[2]	1.5	1.75	2	2.5
	b[3]	2.6	2.9	3.3	3.7
	c[4]	8	10	10.7	15
Deflection in., As cast	a[2]	0.17	0.16	0.18	0.13
	b[3]	0.28	0.28	0.28	0.34
	c[4]	—	0.30	0.30	0.40
Mod of Rupture 1000 psi As cast	a	70	80	91	114
	b	69	78	88	98
	c	63	76	82	115
Hardness[5], Bhn As cast	a	220	230	260	300
	b	210	220	240	290
	c	190	210	230	275
Fatigue Str[6] (End Limit), 1000 psi As cast	b	17.5	21	25	—
Compressive Str[7], 1000 psi As cast	a	150	—	—	—
	b	125	143	150	170
Shear Str, 1000 psi As cast	b	43	57	—	—
Fabricating Properties Machinability Index AISI B1112=100		Gray cast iron having a ferrite matrix, in which graphite flakes are dispersed, has a machinability rating of 110. When a cast iron microstructure shows alloy segregation, free carbides, steadite and free pearlite, machinability is reduced and may be as low as 40. Some castings show several structures due to cooling rate and section size.			
Joining		Can be joined by gas welding, shielded metal-arc welding using special electrodes, carbon arc welding. Preheating necessary. Can be brazed with nonferrous filler metal.			
Corrosion Resistance		More resistant to some types of corrosion than carbon and low alloy steels possibly because of graphite; cast iron soil pipe usually lasts longer than steel pipe, for example. Gray irons are resistant to strong sulfuric acid, cold concentrated phosphoric and nitric acids, attacked by dilute sulfuric, phosphoric and nitric. Resistant to many alkalies including sodium hydroxide, soda ash and ammonia.			
Typical Uses		Clutch plates, crank cases, light brake drums, liners, sleeves, cylinder blocks, impellers, machine components.	Gears, cam shafts, heads, liners, valves, pumps, tube supports, dies, wheels.	Gears, valves, heads, blocks, steam pressure castings, dies, compressors, pumps, rams.	Special brake drums, pressure castings, crusher frames, hot forming dies, heavy duty gears, hydraulic cylinders.

[a] Light sections
[b] medium sections
[c] heavy sections
[1] at ¼ transverse load
[2] 0.876 in. dia by 12 in. between supports
[3] 1.2 in. dia by 18 in. between supports
[4] 2.0 in. dia by 24 in. between supports
[5] Considerably wider range obtainable by heat treatment
[6] About 40% of tensile strength appears to be safe level for endurance limit
[7] In general, the compressive strength is 3 to 5 times the tensile strength

Prepared with the assistance of the Gray Iron Founders' Society

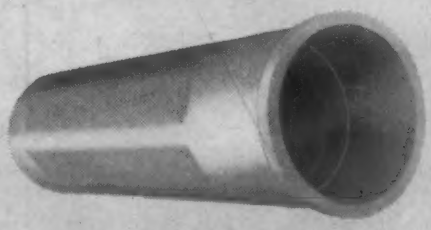
Thermalloy* retorts stay on the job longer...

A large ball and roller bearing company found retort service life increased 30% after they installed Thermalloy retorts. The retorts were used to heat-treat ball-thrust bearing races at an average temperature of 1750°F. for five continuous hours. The specially designed octagonal shape also provided more uniform tumbling action with less marring of parts.

In our Elyria foundry, the most modern facilities are available to turn out quality high-alloy castings. In addition, retorts and muffles are X-ray inspected and pressure tested before shipment to make sure your Thermalloy castings give longer hours of trouble-free service.

For further information on Thermalloy retorts, write for Bulletin T-239. Electro-Alloys Division, 7001 Taylor St., Elyria, Ohio.

*Reg. U. S. Pat. Off.



Thermalloy octagonal retort

Thermalloy pit-type retort

Thermalloy shaker hearth muffle

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

Elyria, Ohio

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NEW MATERIALS PREVIEWS

Two new thermoplastics
Silicone rubbers
Versatile polyamide resins

Two boilable thermoplastics . . .

Polymethylstyrene
Methylstyrene-acrylonitrile copolymer

■ Two injection molding compounds with unusual heat resistance have been developed. Polymethylstyrene is a substituted styrene polymer similar to polystyrene except that it shows no distortion after extended exposures at temperatures up to 212 F. The other material is a methylstyrene-acrylonitrile copolymer in which similarly high heat resistance is coupled with the improved properties usually associated with conventional styrene-acrylonitrile copolymers.

The new plastics were developed by the *Plastics and Resins Div., American Cyanamid Co.*, 30 Rockefeller Plaza, New York 20, and are marketed under the designations PDL-2-400 for polymethylstyrene and PDL-2-201 for the acrylonitrile copolymer. The molding powders are currently available in trial lot quantities, though commercial availability is expected by June of this year. Cost of polymethylstyrene is expected to be competitive with that of general-purpose polystyrene, and the copolymer should be competitive with styrene-acrylonitrile copolymers.

Properties of polymethylstyrene

Polymethylstyrene has a heat distortion point of 203 F (264 psi load). This compares favorably with 185 F for general-purpose polystyrene and 190 to 199 F for heat-resistant polystyrenes. Shrinkage after 40 days (equilibrium) of dry heat at 212 F is 0.8%. Shrinkage after 30 min in boiling water is 0.2%, compared with 1.5% for heat-resistant polystyrene. When a ½x½x5-in test bar is exposed to a 264 psi load at 212 F, it distorts 0.06 in., compared with 1 in. for general-purpose polystyrene and 0.20-1 in. for heat-resistant polystyrene. Shrinkage after immersion in boiling water for 30 min, followed by exposure to dry heat at 225 F for 2 hr is 1.6%.

In addition to unusual heat resistance, polymethylstyrene is said to have all the desirable characteristics of polystyrene, including good color, clarity and dielectric properties.

Properties of copolymer

Just as copolymerization of styrene with acrylonitrile has improved polystyrene's toughness, heat resistance, chemical inertness and resistance to abrasion and crazing, so methylstyrene and acrylonitrile have been copolymerized to produce the same improvements in properties over polymethylstyrene. The resultant copolymer combines these improved

TYPICAL PROPERTIES OF METHYLSTYRENE AND METHYLSTYRENE-ACRYLONITRILE COPOLYMER

Property	ASTM Test	Polymethylstyrene	MS–AN Copolymer
Specific gravity	D792	1.03	1.06
Mold shrinkage, in./in.	—	0.0046	0.0035
Elongation, %	D638	2.2	2.5
Tensile strength, psi	D638	6600	9700
Flexural strength, psi	D790	12,900	16,100
Izod impact strength, ft lb/in. notch	D256	0.33	0.40
Hardness, Rockwell	D785	M76	M83
Flexural modulus of elasticity, psi	D695	400,000	460,000
Dielectric strength, V/mil	D149	890*	430
Dielectric constant	D150	—	—
10^3 cycles	—	2.52 ± .02	2.92
10^6 cycles	—	2.48 ± .02	2.81
Power factor	D150	—	—
10^3 cycles	—	0.0003	0.0057
10^6 cycles	—	0.0006	0.0078
Light transmission, %	D791	88–90	88–90
Heat distortion temp. (264 psi), F	D648	203	207
Distortion after 15 min in boiling water (212 F), in.	—	0.060	0.060
Water absorption, % in 24 hr	D570	0.05	0.31
Effect of acids	—	Attacked by oxidizing acids	
Effect of alkalies	—	None	None
Effect of organic solvents	—	Soluble in aromatic and chlorinated hydrocarbons	Soluble in ketones, esters and some chlorinated hydrocarbons

* *Value for 1/16-in. specimen. No failure in 1/8 in.*

G.E. selects Enjay Butyl for versatile indoor-outdoor transformer casing

The use of Enjay Butyl in General Electric's molded transformer housing solved *three* particular problems—*insulation, support, casing.* G.E.'s engineers found that Enjay Butyl has low moisture absorption, fine resistance to corona and sunlight, and excellent adhesion to copper. In addition, it has a low power factor and good resistance to impact damage.

In electrical manufacturing and design, Enjay Butyl offers three outstanding features: excellent electrical properties, low cost, and immediate availability.

Enjay Butyl may well cut costs and increase the performance of *your* product. Get the facts on this extremely versatile, low-cost rubber. Complete laboratory facilities and technical assistance are at your service. Contact the Enjay Company today.

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NEW MATERIALS PREVIEWS

roperties with the high heat re-istance of polymethylstyrene.

The copolymer has a heat dis-rtion temperature of 207 F (264 si load). Shrinkage after 40 days equilibrium) of dry heat at 212 is 1.4%, and shrinkage after 30 in in boiling water is 0.2%. When a ½x½x5-in. test bar is xposed to a 264 psi load at 212 F, distorts 0.35-1.0 in. Shrinkage fter immersion in boiling water r 30 min, followed by exposure dry heat at 225 F for 2 hr is nly 8%, whereas ordinary heat-esistant polystyrene exposed to he same conditions is completely arped. The accompanying table ists physical properties of both he methylstyrene - acrylonitrile opolymer and polymethylstyrene.

Molding and applications

In general, Cyanamid's two new olding compounds have the ex-ellent moldability of polystyrene nd require only minor alterations n molding conditions. Normal ressures and cycle times are used. A 50 to 75 F increase in cylinder nd mold temperatures is recom-mended, though not always neces-sary. The new compounds have been evaluated in common makes of injection molding presses as well as in many types of molds. Common types of mold gating may be used.

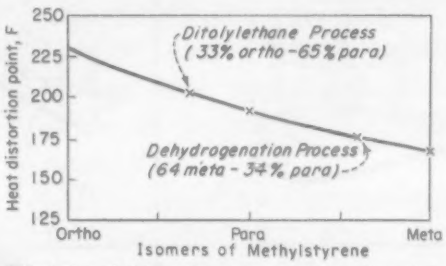
The materials are expected to find wide usage in products for which polystyrene has been used, but where improved resistance to dry heat or hot water is desirable. Such conditions are found in housewares, radio cabinets, parts for dishwashers and hot water tanks, communications equipment, packaging, decorative lighting, toys, refrigerator parts and sim-ilar types of products.

(More Previews on p. 149)

What is Polymethylstyrene?

One of the principal shortcomings of polystyrene has been its relatively low heat resistance. Improvements in heat resistance have been gained by reducing the residual content of unreacted monomer in the polymer, or by copolymerization of styrene with other monomers. However, where good heat resistance has been obtained, it has been at the expense of color, clarity and cost.

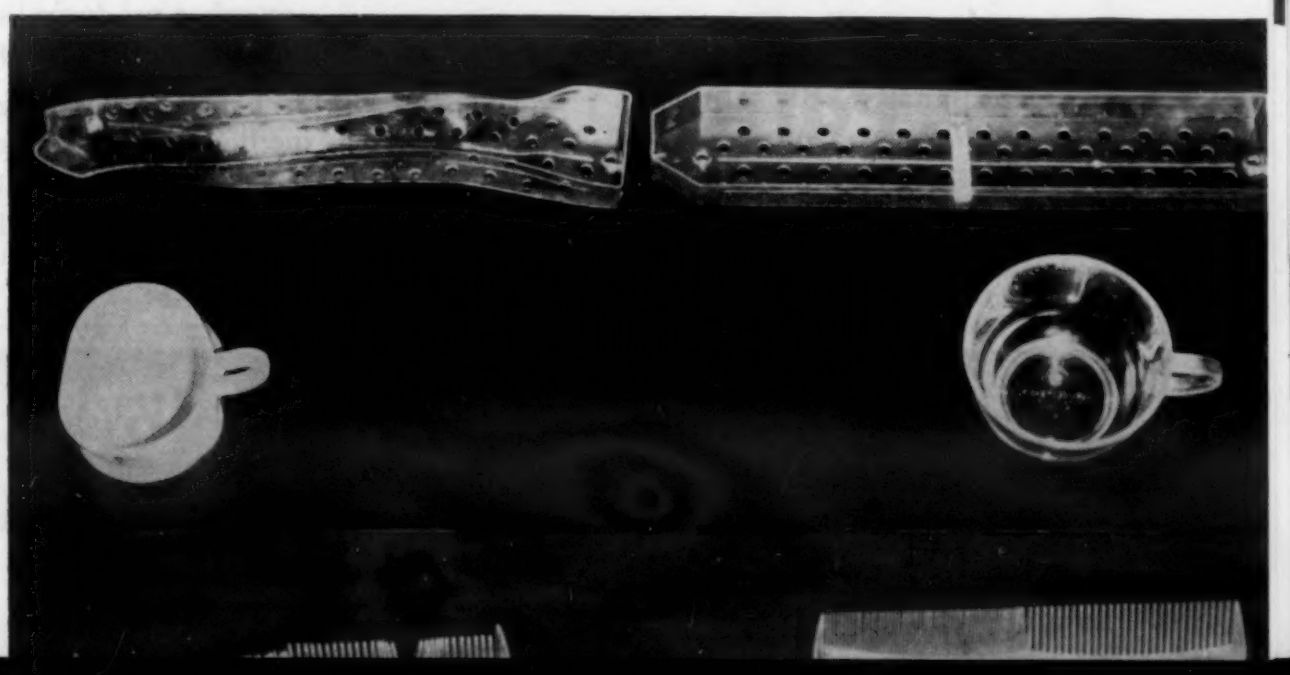
An alternate approach to the problem has been the development of substituted styrenes. Cyanamid's methylstyrene is one of these materials. It is produced by condensation of two moles of toluene with one mole of acetylene to form a mixture of asymetrical ditolylethanes which are then cracked in the vapor phase to yield methylstyrene and toluene. Toluene and other impurities are distilled off to yield methylstyrene of at least 99.7% purity. The methylstyrene monomer produced in this manner consists of three isomers: about 65% para, 33% ortho and 2% meta. The amount of each of the three isomers determines the heat resistance of the material. By contrast, methylstyrene produced by another commercial process, which starts with ethylene instead of acetylene and utilizes dehydrogenation, consists of 64% meta, 34% para and 2% ortho isomers. As the accompanying graph shows, the ortho isomer contributes most to heat resistance and meta the least. Hence, the methylstyrene monomer made by Cyanamid's process yields polymers having better heat resistance than those produced from hydrogenated methylstyrene monomers.



Effect of methylstyrene isomers on heat distortion point

Cyanamid has found that, as well as being used to produce polymethylstyrene and the methylstyrene-acrylonitrile copolymer, the methylstyrene monomer can be used as at least the equivalent of styrene in other fields. Its polymerization characteristics are very similar to those of styrene. It has proved to be equivalent to styrene in GR-S formulations; no preferential isomer build-up occurred when methylstyrene was exhaustively recycled with butadiene. It has been successfully evaluated in latex and styrenated alkyd paints. It has certain advantages over styrene when used in alkyds, since it is more compatible with the less expensive solvents. It has also shown promise in paper, textile and polyester resin applications.

These plastics parts *were all subjected to immersion in water for 30 min at 212 F. On the left from top to bottom are styrene-acrylonitrile copolymer junction box, styrene-acrylonitrile copolymer cup and a polystyrene comb. On the right are methylstyrene-acrylonitrile junction box, methylstyrene-acrylonitrile cup and a polymethylstyrene comb.*



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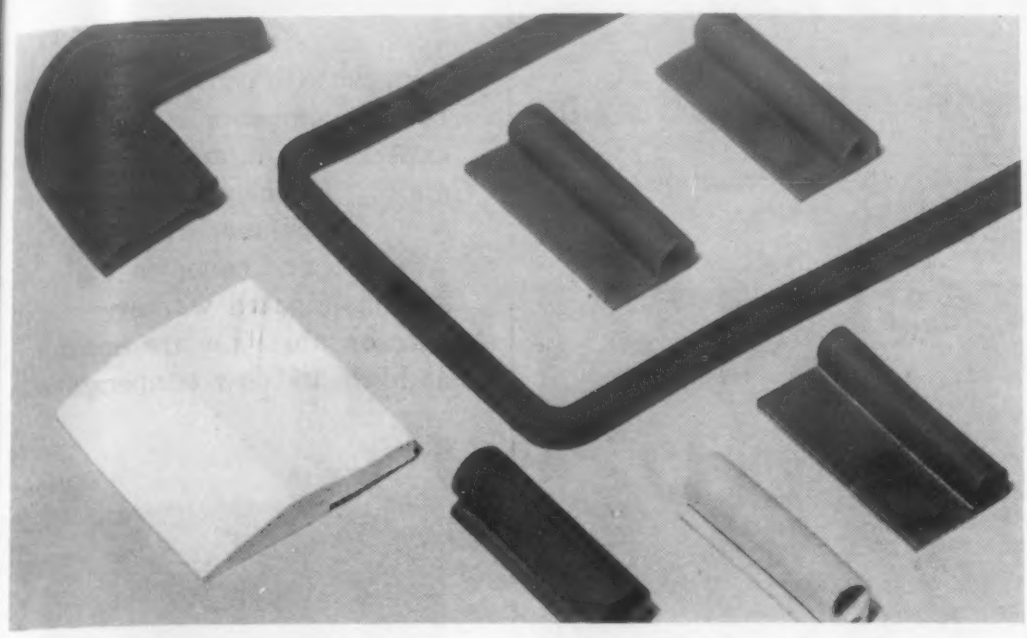

The new silicone rubber *formulations are expected to find wide applications in extruded and molded seals such as these.*

From —65 to 400 F . . .

Silicone Rubbers

have high tensile and tear strengths. They meet these specifications ▼

COHRLASTIC HT SPECIFICATIONS

Properties	HT 655	HT 666
As Received:		
Hardness, Durometer "A"	50 ± 5	60 ± 5
Tensile Strength, psi, min	1250	1000
Elongation, %, min	700	550
Tear Resistance, lb per in., min	175	175
ASTM No. 1 Oil Resistance, 70 hr at 300 F		
Hardness Change, Durometer "A"	− 10 to + 5	− 10 to + 5
Tensile Strength Change, %, max	− 40	− 25
Elongation Change, %, max	− 40	− 35
Volume Change (Method A), %	+ 15	+ 15
Decomposition	None	None
Surface Tackiness	None	None
Dry Heat Resistance, 70 hr at 400 F		
Hardness Change, Durometer "A"	+ 20	+ 15
Tensile Strength Change, %, max	− 35	− 30
Elongation Change, %, max	− 45	− 40
Tear Resistance Change, %	Positive	Positive
Surface Hardening	None	None
Bend (flat)	No Cracking	No Cracking
Compression Set, % of Original Deflection		
70 hr at 212 F (Method B)	35	35
70 hr at 300 F (Method B)	75	75
Low Temperature Resistance		
Young's Modulus 10,000 psi, max		
at − 65 F	Pass	—
at − 100 F	—	Pass

■ Extruded and molded parts made of two new silicone rubber compounds are now available with tensile and tear strengths and elongations approximately twice those of conventional silicone rubbers.

Developed by *Connecticut Hard Rubber Co.*, 407 East St., New Haven 9, Conn., the materials retain a relatively high percentage of these values after exposure to temperatures ranging from —65 to 400 F. Newest additions to the Cohrlastic HT series (see M&M, Jan 1955, p. 142), the two new compounds are Cohrlastic HT 655, a methyl base material, and HT 666, a methyl phenol base material. The higher strengths, as well as higher abrasion resistance, are attributed to the use of an ester-coated fine silica filler called Valron, developed by du Pont.

The HT 655 compound is particularly designed for elevated temperature service. At room temperature, the cured compound has tensile strength of about 1650 psi, elongation of 900% and tear strength of about 197 lb per in. When tested at 400 F, it has a tensile strength of about 655 psi, elongation of 390% and tear strength of 100 lb per in. The HT 666 material has original properties slightly lower than those of HT 655, but is said to have outstanding low temperature flexibility at —100 F. The accompanying table lists specifications which the compounds meet or exceed.

What is Valron?

Valron is essentially a fine silica powder coated with an organic ester. The material exhibits curing action in itself. Previous attempts to use it as a reinforcing material for silicone rubber have been hindered by its rapid cure and its deteriorating effect on silicone rubber at elevated temperatures. According to Connecticut Hard Rubber, this problem has been solved by the inclusion of an anti-oxidant which inhibits Valron's rapid cure.

Applications

The materials in the form of extruded or molded parts are now

NEW MATERIALS PREVIEWS

commercially available at prices approximately one-third higher than those of conventional silicone rubber compounds. The producers expect initial applications to be mainly in the aircraft field, e.g., seals for pylons, drag chute doors, windows and canopies. Other uses are anticipated wherever tension, tear or abrasion are encountered at high and low temperatures.

***Blends of Versamids** and epoxies form low cost, non-toxic resin systems for plastics tooling.*

Versatile Polyamide Resins

A new series of thermoplastic polyamide resins ranging from hard, tough solid materials to liquid compounds for adhesives and coatings has been developed by the *Chemical Division of General Mills, Inc.*, General Mills Bldg., Third Ave. S., Minneapolis, Minn. Called Versamids, the new plastics are based on vegetable oils which are reacted to produce plastics monomers. Though chemical derivatives of these oils have been used for about ten years in finishes and adhesives, they are only now available as a well defined family of plastics. Typically, they are prepared by the condensation of polymerized unsaturated fatty acids, such as dilinoleic, with aliphatic amines.

Six Versamid materials, varying in molecular weight, viscosity and softening point, are currently available. Solid Versamids are

MARTIN BALTIMORE

saves $18,500 in first year with one barrel using **Lorco** compounds and chips.

Barrel finishing has been a very profitable operation for the Martin Company, Baltimore. Using Lorco compounds and chips, they saved an estimated $18,500 in one year of operation in their first large barrel (13 cu. ft.). And, while only very small parts could be finished originally, they are now tumbling everything from tiny clips to complex forgings weighing up to 12 pounds, resulting in even greater savings.

Today, Martin employs modern tumbling techniques to deburr and descale approximately 20,000 of the 28,200 parts required on each of one type of ship. They are barrel finishing between 25,000 to 30,000 parts a week . . . at the remarkably low cost of only ¾ of a cent per part. These parts include stampings, forgings, castings, formed parts, and extrusions made of aluminum, steel, stainless steel, brass, copper, magnesium . . . *and even plastics.*

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NEW MATERIALS PREVIEWS

amber-colored thermoplastics with molecular weights ranging from 3000 to 10,000 and with softening points ranging from 115 to 375 F. In general, they are non-flammable, non-toxic, and resistant to water, alkalies, most acids, oils and to many organic solvents. Dielectric characteristics are said to be excellent. Each of the Versamids is compatible with other Versamids and with many liquid and low-melting monomeric plasticizers. Some are compatible with certain waxes. All are compatible with most phenolics, with natural resins and their derivatives, and with maleic resins. Several of the fluid Versamids are compatible with epoxy resins, and combinations of Versamids and epoxies are one of the most promising applications for the materials.

Types of resins

The six types of Versamids are:

1. **No. 900**—A hard, tough resin with the highest molecular weight and highest softening point (355-375 F) of the group.
2. **No. 930**—A hard, tough resin with a somewhat lower molecular weight and a softening point of 220-240 F.
3. **No. 940**—A resin similar to 930, but with slightly lower molecular weight.
4. **No. 950**—Resembles 940 and 930, but has increased flexibility and low rate of vapor transmission in thin films. It has good blocking resistance and a softening point of 200-220 F.
5. **No. 100**—A soft, tacky resin with excellent adhesive and plasticizing properties. It has a softening point of 109-127 F.
6. **No. 115**—A viscous liquid highly reactive with epoxy resins and used as a basis for a series of blended compositions.

Resin 900 can be used to raise the softening point of the other resins. Resins No. 930, 940, and 950 can be applied from solvents as overprint lacquers or varnishes on printed cardboard boxes, printed cellophane or other container

OTHER NEW MATERIALS, PRODUCTS

materials. Advantages are good grease and water resistance, good gloss and protection for the printed stock. The solvent solution can be colored with dyes to obtain a multicolored effect.

Epoxy blends

Resins 100 and 115 react with epoxy resins to produce a new group of compounds. Blending resin 115 with liquid epoxies produces adhesives, potting compounds and laminating varnishes that, after polymerization, become thermosetting materials. The Versamid component imparts initial tack and, after cure, becomes an internal plasticizer. The cured materials are said to have greater resistance to impact and thermal shock than amine-cured epoxies. They show good resistance to most chemicals, and have a high degree of adhesion to a wide variety of materials. They can be prepared without use of solvents, and they cure at moderate temperatures.

With adhesive blends consisting of equal parts of 115 resin and epoxy, plus about 16% filler, tensile shear strengths of typical bonds on aluminum are about 2700 to 3500 psi. Increasing the Versamid proportion increases the flexibility of the bond.

Improved Brightener for Cadmium Plates

A Cadalume Process for bright cadmium plating in still tanks has been developed by *Hanson-Van Winkle-Munning Co.*, Church St., Matawan, N.J. It is said to make bright dips unnecessary, though a conversion coating may be applied if desired. Cadalume brightener may be added directly to the bath. No break-in period is needed, and the desired brightness appears immediately in a balanced bath.

The process increases plating speeds, improves deposit distribution and throwing power, and produces heavy deposits where required without loss of brilliance

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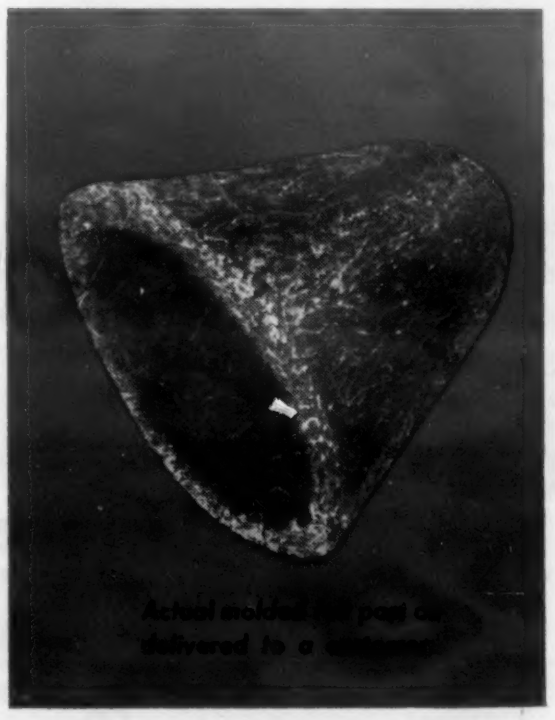

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WRITE for our recommendation of a molded American Felt part to your specifications.

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OTHER NEW MATERIALS, PRODUCTS

or formation of surface defects. Although the Cadalume deposit has a high degree of brightness as deposited, a 1% nitric acid bright dip may be used to brighten low current-density areas on deeply recessed work. The process can be used to protect iron and steel parts against corrosion, and nonferrous metals against surface tarnish, corrosion or galvanic couples formed in assemblies.

In general, either a conventional cadmium solution or a bright cadmium bath can be converted to the Cadalume process by adjusting the solution to the following optimum formula:

Cadmium oxide	**3.5**	**oz/gal**
Sodium cyanide	**15.0**	**"**
Cadalume Brightener	**1.28**	**fl oz/gal**

The bath is a clear solution, simplifying arranging of work in the tank. Unlined steel tanks have proved satisfactory; rubber-lined steel tanks can also be used. Steel or copper racks may be used provided they are insulated to conserve metal and current and to prevent contamination of the solution.

Aluminum Casting Alloy Is Low in Nickel

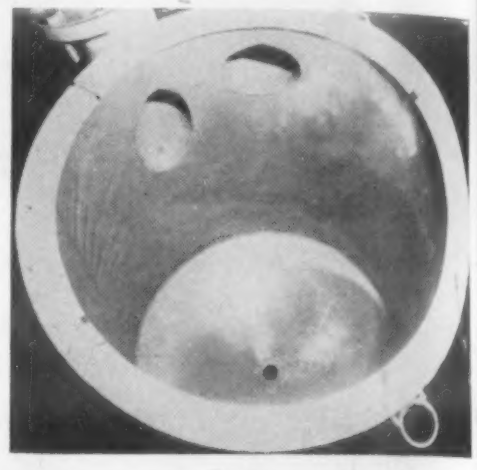
An aluminum casting alloy with a maximum nickel content of 0.5% has been developed by *Aluminum Co. of America*, 1501 Alcoa Bldg., Pittsburgh 19. Designated F132, the new alloy was developed primarily to replace Alcoa's automotive piston alloy, D132, which has a nickel content of 0.5-1.5%. In case of an emergency which would curtail the use of nickel, the new alloy would be more readily available.

Properties of the new alloy are said to be virtually identical to those of D132. Typical mechanical properties in the —T5 condition are: tensile strength, 36,000 psi; yield strength, 28,000 psi; elongation in 2 in., 1.0%; and Brinell hardness, 105 with a 500 kg load and a 10 mm ball.

Chemical composition of the new alloy is as follows: 2.0-4.0

OTHER NEW MATERIALS, PRODUCTS

copper, 1.2 max iron, 8.5-10.5 silicon, 0.5 max manganese, 0.5-1.5 magnesium, 1.0 max zinc, 0.5 max nickel, 0.2 max titanium, 0.5% max total of others. Engine testing and elevated temperature testing of pistons indicate that the higher zinc limit will not adversely affect performance characteristics.

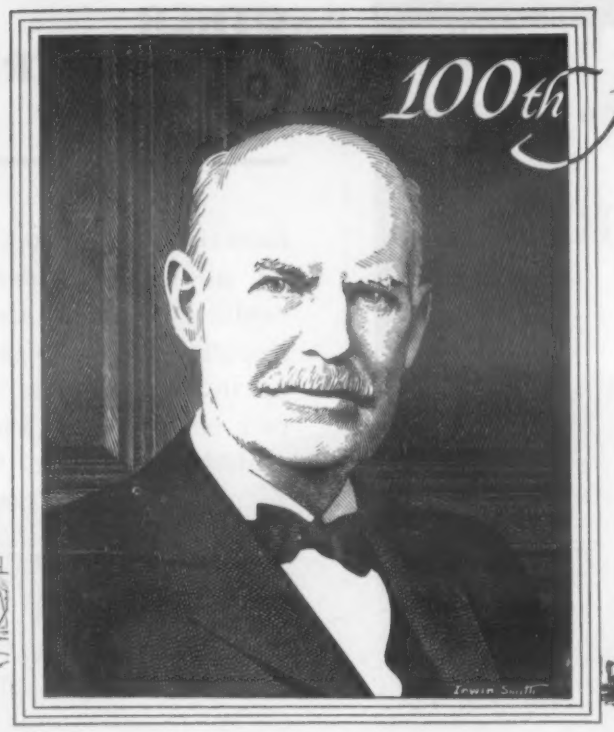


Fluorocarbon, Glass Combined in Laminate

A fluorocarbon-glass laminate, consisting of a 10- to 12-mil thick continuous layer of Kel-F plastic on glass cloth has been developed by M. W. Kellogg Co. and is being produced and marketed by *U.S. Gasket Co.*, Camden, N. J., and *Garlock Packing Co.*, Palmyra, N. Y.

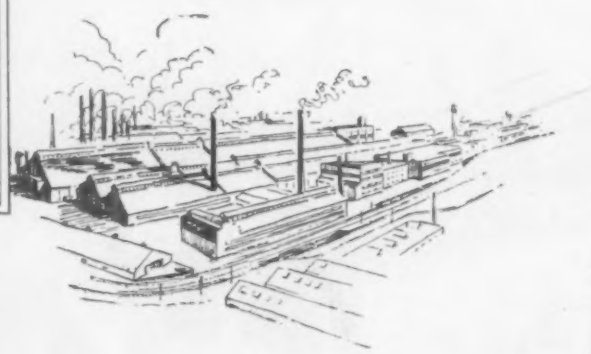
The material is produced by depositing the fluorocarbon from a dispersion (see M&M, Nov, '55, p. 90) to form a mechanically bonded continuous layer on glass cloth. The laminate can then be adhesive-bonded to almost any contoured surface, the adhesive forming a bond between the glass and the surface to be coated. The laminate provides a high degree of temperature and chemical resistance to surfaces to which it is applied.

Recommended installation techniques call for 1) cleaning and roughing the surface to which the laminate is to be cemented, 2) cutting and fitting the laminate, 3) applying an adhesive such as an epoxy-rubber blend to both



100th Anniversary

INVENTOR
SCIENTIST
INDUSTRIALIST



this was genius . . .

EDWARD GOODRICH ACHESON

Yes, this was genius.

Thomas A. Edison knew it. In paying tribute upon the occasion of Doctor Acheson's passing, he said ". . . as a former associate I know the world loses a great genius."

Leo Hendrik Baekeland knew it. He remembered him "as a man who combined a most fertile brain with great strength of conviction."

Walter B. Pitkin knew it. This famous psychologist said "As he created his place in our civilization so does that place pass with him. None shall fill it."

And the press knew it. They used in their editorials such phrases as "world's acclaim of a genius," "one of the geniuses of his time," and "the loss of an inventive genius."

But what makes genius?

Employing a mixture of carbon, sand, salt, and sawdust in a simple but effective electric furnace, made up of a few strands of wire, a carbon rod, and a plumber's bowl, Edward Goodrich Acheson was able to bring into being a mass of scintillating crystals rivaling many gems in splendor and almost matching the diamond in hardness. These highly abrasive crystals he crushed and made into grinding wheels, and these wheels, in turn, were used to shape metals and make machines. Called "Carborundum" by Acheson and silicon carbide by the chemist, this new material did its job so well that it is credited with making possible today the mass production of automobiles, tractors, and countless other mechanisms.

Possibly silicon carbide could be made better—harder or sharper. To this end Acheson subjected silicon carbide to higher temperatures for longer periods; what he obtained was not a harder substance but, instead, one of the softest—pure graphite. The extreme conditions to which he had exposed his jewels of industry brought about their disintegration, the silicon passing off as vapor and the carbon remaining as a soft, unctuous residue. Manufactured graphite, destined to be of far-reaching importance, became another of Acheson's contributions to industry.

Unquenchable curiosity, coupled with the indomitable spirit that was his, led him to uncover means of preparing this new product of the electric furnace in the form of plates and cylinders. Put to work as electrodes, these soon revolutionized electrochemical and electrometallurgical operations. Acheson had now made commercially feasible the production of new families of chemicals and laid the groundwork for the present efficient manufacture of steel and alloys.

During Acheson's painstaking efforts to produce graphite crucibles he experimented with many clays for use as binding agents—and he learned much about them—so much in fact that he was able to explain why the ancient Egyptians used straw in their brick making and what caused the formation of the deltas of the Nile and Mississippi. Most important, he discovered a method of rendering graphite colloidal.

Colloidal graphite in modern industry plays a role that is varied and complex, its unique properties finding utility in such dissimilar fields as lubrication, electronics, metalworking, and lithography, to name a few. The techniques originated by Acheson for colloidally dispersing graphite are being applied to other solids including carbon blacks, pigments, and minerals.

To those of us in the companies identified with Doctor Acheson, his perseverance and achievement are an inspiration. We are proud to offer this tribute to his genius on the 100th anniversary of his birth.

Acheson Industries, Inc.

ACHESON COLLOIDS COMPANY
PORT HURON, MICH.

ACHESON DISPERSED PIGMENTS CO.
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LONDON, ENGLAND

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OTHER NEW MATERIALS, PRODUCTS

laminate and supporting surface, 4) allowing adhesive to set, 5) sealing seams, and 6) testing electrically for presence of pinholes or incomplete seams. The sheets can be cut with knife or shears, and they can be either cold or hot formed to flat or compound curvatures.

Properties of the material parallel those of Kel-F, including: resistance to temperatures approaching 400 F; low temperature flexibility; high degree of resistance to alkalies, mineral acids, strong oxidizing acids and solvents; low permeability to moisture and organic and inorganic liquids and vapors; high abrasion resistance and tensile strength; low cold flow; high impact resistance; and high dielectric strength and electrical resistivity.

The laminate is particularly recommended as a lining for tanks, vessels, reactors, drums, pails, pipe, chutes, hoppers, fume hoods and ducts. As a surfacing material, the material is expected to broaden the effective application range of reinforced plastics and honeycomb structures.

Enamel, Lacquer Have Better Gloss Retention

Two automobile finishes that are said to eliminate car waxing for at least 18 months under normal conditions of service have been developed by *E. I. du Pont de Nemours & Co.*, Wilmington, Delaware. Called Lucite and Dulux 100, the new finishes are claimed to retain their gloss three times longer than conventional car paints.

Dulux 100

Dulux 100 synthetic resin enamel is as hard immediately after baking as conventional enamels after several months' aging. The enamel can be held at 275 F for as long as three hours without appreciable color change. Unlike other synthetic enamels, Dulux 100 can be buffed to remove minor scratches and abrasions. Since it requires

OTHER NEW MATERIALS, PRODUCTS

a moderately high bake to harden the film, it is not suitable for refinishing. Cured coats of Dulux 100 are also said to be highly blister-resistant.

Lucite

Lucite acrylic lacquer, presently available only on a limited scale, is based on the same chemicals as clear Lucite acrylic resin. In addition to ease of maintenance, the new lacquer provides new color effects, achieved by blending metallic powder and pigment in combinations previously impossible to attain. Reflection of light from metallic particles imbedded in the coating as viewed from various angles imparts a depth of hue and range of color.

Road tests indicate that both of the new finishes will reduce problems of oil or grease staining in service.

Universal Finish for Glass Cloth

A new finish for heat-cleaned glass cloth is said to be effective with epoxy, phenolic, polyester and silicone resins, enabling laminators to meet a wide range of specifications with a single type of finished cloth. Developed by *Dow Corning Corp.,* Midland, Mich., the finish is called Dow Corning T-31 and consists of a solution of a silicone resin in methyl cellusolve. One part of T-31 may be diluted in 60 to 80 parts of water for application in conventional finishing equipment. Priced in the range of $6 per lb, the new finish is estimated to add about 5 cents per yard to the materials cost of finished glass cloth.

Adhesives and Cements

Five adhesives and cements have recently been developed. They include three structural adhesives for bonding metals or plastics, a cement for PVC piping and a cement for nylon.

Three structural adhesives

Two variations of a resin-type

OTHER NEW MATERIALS, PRODUCTS

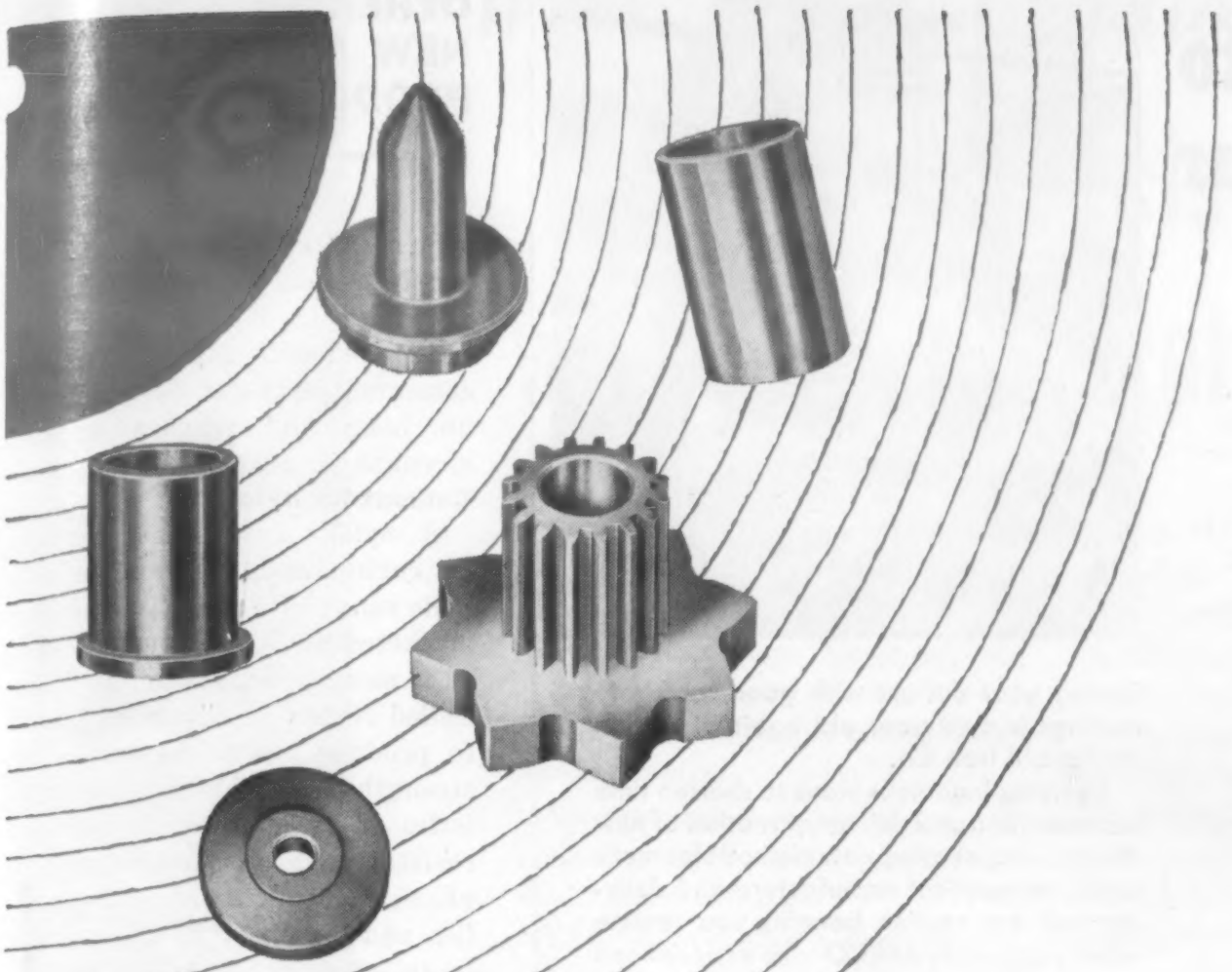
thermosetting adhesive have been developed by *Minnesota Mining and Mfg. Co.*, 411 Piquette Ave. Detroit 2, for joining sandwich constructions consisting of phenolic-impregnated kraft paper honeycomb and thin aluminum, stainless steel or magnesium sheeting. One adhesive, EC-1177, is a transparent, synthetic resin-base material weighing about 7.7 lb per gal. It is diluted with an equal volume of acetone for spraying. The other, EC-1415, is a transparent, amber colored material. It weighs about 7.4 lb per gal and can be sprayed as received.

To fabricate a honeycomb panel with these adhesives the metal is first chemically cleaned and thoroughly dried. The adhesive is then sprayed on to a thickness of 0.015 in. Following a 30-min air drying period, the coated sheets and honeycomb core are put in an oven and force dried separately for 10 min at 190 F. After cooling, sheets and core are mated and the panel placed in a press under approximately 15 psi pressure for a maximum of 15 min at 300 F.

The third structural adhesive consists of a two-component epoxy system and is designed for bonding steel, brass, copper, aluminum, zinc, iron, tin, glass, wood, plastics and other surfaces to themselves and to each other. Called Resiweld, and produced by *H. B. Fuller Co.*, 181 W. Kellogg Blvd., St. Paul 2, Minn., the material is said to set without the aid of clamps, does not shrink, is resistant to water, solvents and chemicals, and provides bonds with high tensile shear strength coupled with high impact resistance. The material cures in 12 hr to five days at room temperature, or in shorter times with an oven cure.

Cement for PVC pipe

A new solvent cement for joining polyvinyl chloride pipe fittings and flanges is said to produce a joint as strong or stronger than the pipe itself. It is also said to be capable of bridging a greater gap than previously available



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112

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OTHER NEW MATERIALS, PRODUCTS

cements. Produced by *Tube Turns Plastics, Inc.*, 2929 Magazine St., Louisville 11, Ky., the cement can be applied with a paint brush. A cemented joint can be handled in an hour and reaches working strength in 48 hr.

Cement for nylon

A nylon cement that requires no curing and is available in a wide range of viscosities has been marketed by *Ions Exchange Corp.*, 44 Leonard St., New York 13. Called Nylosil, the cement is said to produce joints possessing the strength and inherent characteristics of nylon itself. It has high resistance to oils, aromatics, aliphatic solvents, fruit acids, alkalies and bleaches. Bonds are said to be effective over a wide temperature range, and the adhesive is particularly effective in filling gaps resulting from imperfectly matched joining surfaces.

Circuit Laminate Has High Bond Strength

A line of copper clad laminates for printed circuit use is said to offer a high bond strength of 12 to 15 lb as well as improved dip solder temperature resistance (30 sec at 500 F). Produced by *National Vulcanized Fibre Co.*, 1055 Beech St., Wilmington 99, Del., the new series, designated Phenolite HP, has been made possible by development of a process which speeds production, provides uniform conditioning of the laminate and the copper foil surfaces, and uses a stronger adhesive for bonding the foil to the laminate. The process is a result of original research conducted by Houghton Laboratories, Inc., for the Army Signal Corps.

Insulating Material Stable at 300 F

An electrical insulating material consisting of glass fabric coated with an isocyanate type resin is said to be thermally stable

Westinghouse radio cabinets

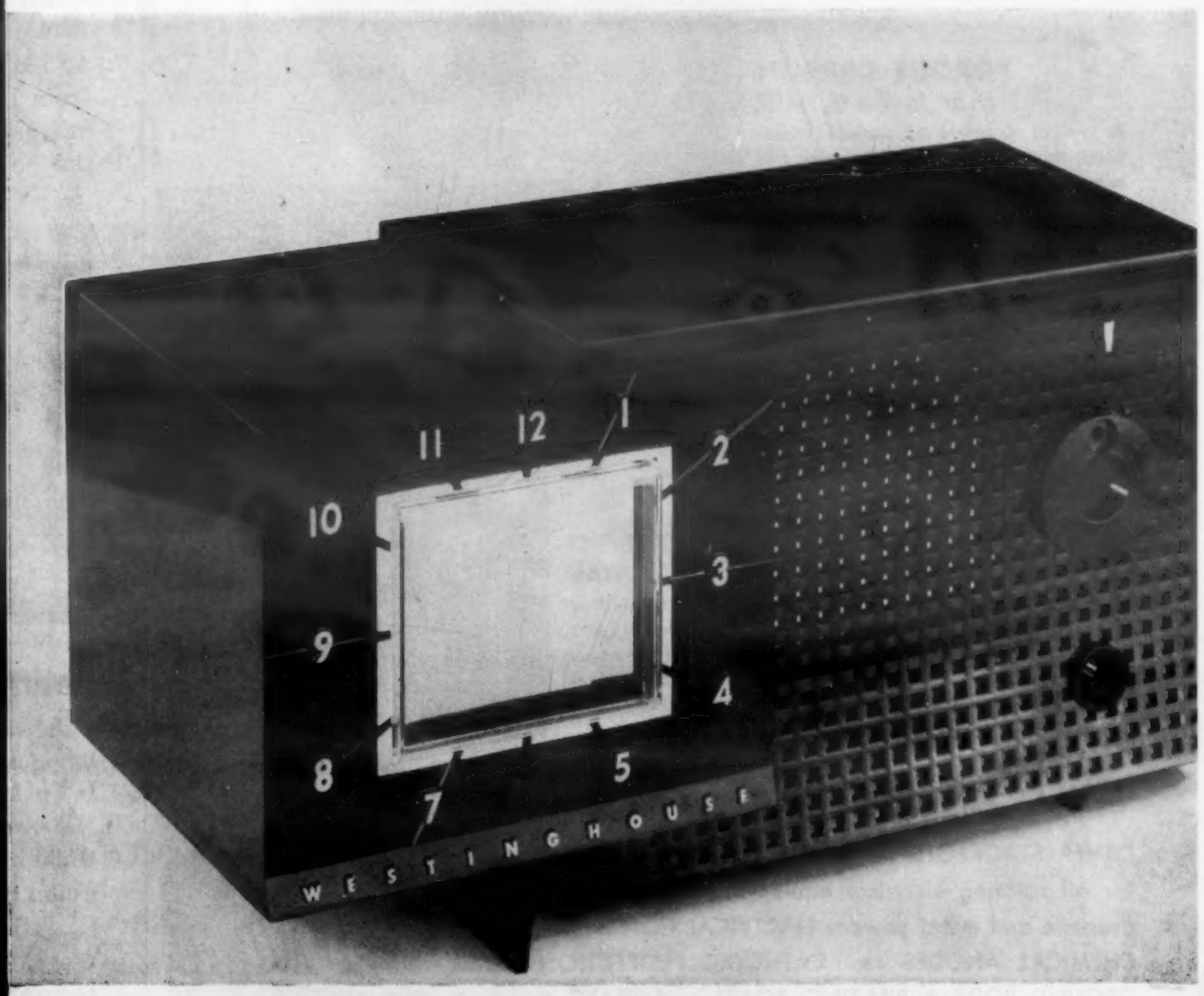
molded in precise detail with DYLENE* Polystyrene

DYLENE polystyrene fills every section of intricate molds because it flows freely at cycling temperatures. The result: a perfect piece that is smooth, glossy and flawless to the most minute detail. The radio cabinet pictured here proves this point.

Westinghouse chose several new and exciting colors from the hundreds of shades and hues that are available in the DYLENE color charts. And this 11" x 6" x 5" radio cabinet weighs *only* 1 lb. 3 oz.

DYLENE polystyrene is the right choice for products that must have high heat resistance, be strong, light weight, easy to mold . . . colorful, smooth, easy to clean. For more complete information about DYLENE polystyrene write to Koppers Company, Inc., Chemical Division, Dept. MM-36, Pittsburgh 19, Pennsylvania.

*Koppers Trademark



Westinghouse radio cabinets are molded by Worcester Molded Plastics Co., Worcester, Mass. and Bridgeport Molded Products, Inc., Fairfield, Conn.

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OTHER NEW MATERIALS, PRODUCTS

at continuous operating temperatures up to 300 F. Developed by *Natvar Corp.*, 211 Randolph Ave., Woodbridge, N. J., the material, available in sheet or tape form, is said to be resistant to crazing, relatively unaffected by rough handling at Class B temperatures and above, and resistant to most chemicals, solvents and oils, including askarels at elevated temperatures. Called Isoglas, the material is expected to find application where Class B materials are not sufficiently heat resistant, and Class H materials are prohibitive in cost.

Tensile strength of Isoglas in the warp direction ranges from 70 lb per in. width for 0.003-in. thick material to 240 lb per in. width for 0.012-in. material. Dielectric strength (¼ in. electrode, ASTM short time test) ranges from 1300 v per mil for the 0.003-in. material to 750 v per mil for the 0.012-in. material.

Foam-In-Place Plastic

A foamed plastic, available as a dry powder which can be foamed in place, has been marketed by *Emerson & Cuming, Inc.*, 869 Washington St., Canton, Mass., under the trade name Eccofoam GL. Supplied as a finely divided, free flowing powder, the material is poured into a cavity, then cures to a low density foam which can be used at temperatures up to 347 F. Properties of the foam at 20 lb per cu ft density include a dielectric constant at 10^{10} cps of 1.48; dissipation factor at 10^{10} cps

It's Practically

WATER-WHITE

a NEW

chemically resistant

baking finish–

DURACHEM

For all types of metal products from heavy hardware to fine jewelry

Here is a new baking type synthetic finish for metal parts that combines unusual clarity with a high degree of chemical resistance.

Product of Maas & Waldstein Co. research, DURACHEM is almost water-white in color—and retains its clarity even after prolonged exposure to heat and sunlight. It also protects metal parts against the effects of salt spray and perspiration.

Typical applications include builders' hardware, vanity and cosmetic cases, lipstick shells and pen caps.

Where decorative color effects are desired on metal, DURACHEM can be supplied in a range of colors with the same chemical stability as the clear finish.

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Samples and technical literature are available on request. Or an M & W technical consultant will discuss your requirements privately with you.

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OTHER NEW MATERIALS, PRODUCTS

of 0.009; and a compressive strength of 600 psi. The foam is said to be particularly well suited for use in embedding electronic assemblies and as cores for radome walls.

Three New Tapes

1. **Polyester laminating tape** A transparent, double-faced Mylar tape, said to be particularly well suited for laminating and splicing applications, has been marketed by *Permacel Tape Corp.*, New Brunswick, N.J. Designated Permacel 94, the tape consists of 1-mil Mylar film coated on both sides with a rubber-base, pressure-sensitive, heat curing adhesive. The tape is protected on both sides by 2-mil films of Mylar which are removed prior to installation.

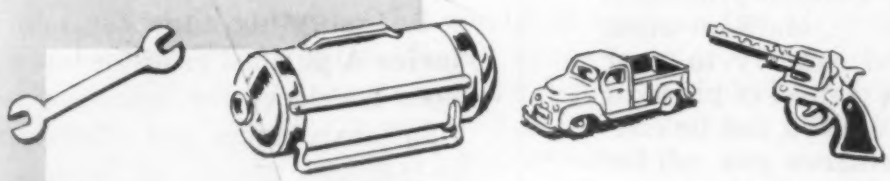
The tape is said to be practical for laminating transparent sheets of all types of material, as well as for joining dissimilar or like metals where paper or cloth backings would be undesirable. The tape has good resistance to aging, low moisture vapor permeability, and resistance to solvents, and it is not bulky. Since the tape has a high elongation of 70% and tensile strength of 20 lb per in. width, it is useful for laminating irregular matching surfaces. The adhesive cures in 2 hr at 250 F or in 1 hr at 300 F. Thickness of the tape as applied is 3.3 mils and adhesion to steel is 40 oz per in. width.

2. **Acoustical damping tape** A pressure-sensitive aluminum foil tape designed primarily to reduce the sound level inside aircraft has been developed by *Minnesota Mining and Manufacturing Co.*, 900 Fauquier Ave., Dept. J6-3, St. Paul, Minn. Called Scoth sound damping tape No. 435, it is designed for use where a high ratio of noise reduction to unit weight is desired. The tape consists of a laminate of two layers of aluminum foil coated with a long aging adhesive. Properties of the 12-mil

Now
as bright as the twinkle in a small boys eyes...

New PROBRITE* BY PROMAT

gives the luster and protection you want in decorative finishes...



Tools, tubular furniture, household appliances and toys are a few applications where chromium plated PROBRITE is used to advantage as a new, durable bright finish.

*

For more information about this amazing new product write for Bulletin 7 - 3 or send a sample of your product to be plated for your evaluation.

IMPROVED, NEW PROCESSING

by Promat's research staff has created a completely new, improved alloy which gives the manufacturer of tools, of tubular furniture, of household appliances and of toys, these tremendous advantages:

1. **PROBRITE can be plated full bright!**
2. **PROBRITE can be buffed!**
3. **Chromium plated PROBRITE sealed in Proseal S-30-A prevents corrosive attack.**
4. **PROBRITE protects and has the luster of the finest decorative finishes!**

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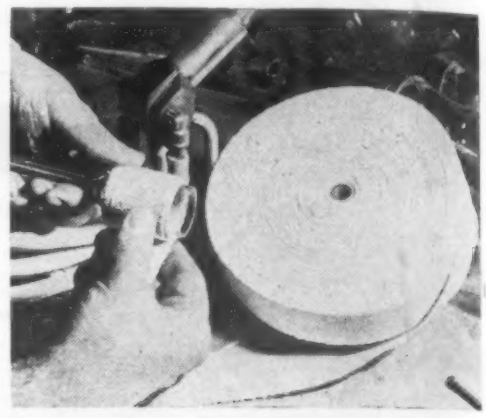
OTHER NEW MATERIALS, PRODUCTS

tape include tensile strength of 50 lb per in. width; minimum adhesion of 50 oz per in. width; weight of 0.112 lb per sq ft; and damping efficiency of 92.0 db/sec/lb/sq ft at 0 F, or 45.5 db/sec/lb/sq ft at 70 F. In addition to the aircraft industry, the tape is expected to find applications in automotive and sheet metal fabrication industries where noise and vibration in the end product is a problem.



3. Insulating tape for laboratories A purified asbestos tape has been developed for insulating distillation columns and other hard-to-insulate pieces of laboratory equipment. Produced by *Fisher Scientific Co.*, 368 Fisher Bldg., Pittsburgh 19, the tape is 1/32 in. thick and is available in widths of 1, 1½ and 2 in., in rolls 100 ft long. It is claimed to be more versatile and tougher than paper sheets it is designed to replace. It is particularly recommended for use in supporting and padding items during complex work in laboratory glass-blowing shops.

Sprayable Plastisol

A new sprayable plastisol material which requires no thinners or solvents has been developed by *Michigan Chrome and Chemical Co.*, 8615 Grinnell Ave., Detroit 13. Called Miccrosol Spray S-2003, the material is said to permit manufacturers to make use of the corrosion resistance of plastisols on items as large as tank cars. Non-porous films as thick as 60 mils can be obtained with no sagging of coat. Where multiple coats

Dragonfly
ANAX JUNIUS

Lightweight

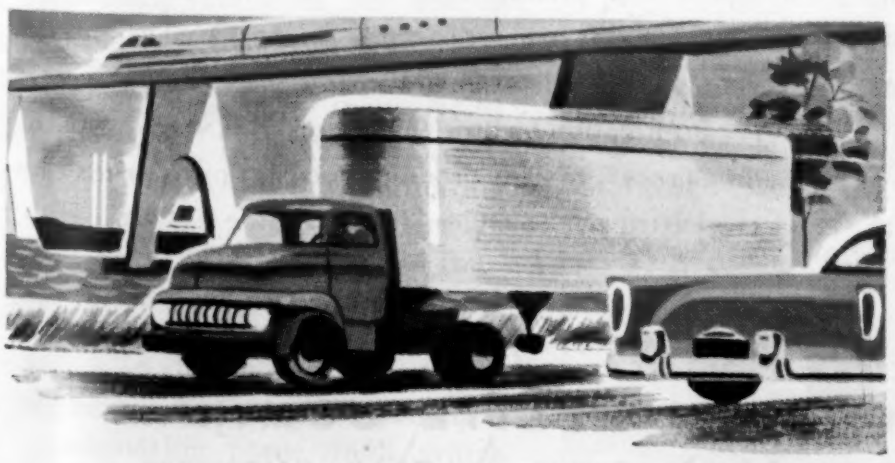
In the world of insects, the Dragonfly (also known as the "devil's darning needle") ranks high for lightweight insofar as size is concerned. It is one of the most active members of the insect kingdom.

This creature can remain almost constantly in the air, flashing forward and backward. It can remain poised in a fixed position and then dart faster than the eye can follow—only to reappear in almost the same spot.

In the world of materials, aluminum is one of the lightest of metals. Aluminum weighs one-quarter to one-third as much as other commercial metals. With proper design, aluminum can cumulate direct weight savings and multiply them many times—as much as ten times in the structure of aircraft. Compared on an equal weight basis with traditional metals, aluminum can give several times the number of parts per pound.

Because rotating and reciprocating parts made of aluminum are light in weight, their inertia forces are low; braking and accelerating forces also are less than with heavier materials.

Aluminium Limited Sales, Inc. is distributor in the United States for aluminum from Canada. Why not investigate making your products of aluminum?



Lightweight

In the construction of Automobiles, Trucks and Trailers, Ships, Trains, Drums and Barrels, aluminum is put to more new uses than any other metal. Lightweight aluminum means extra payloads and more economical operation.

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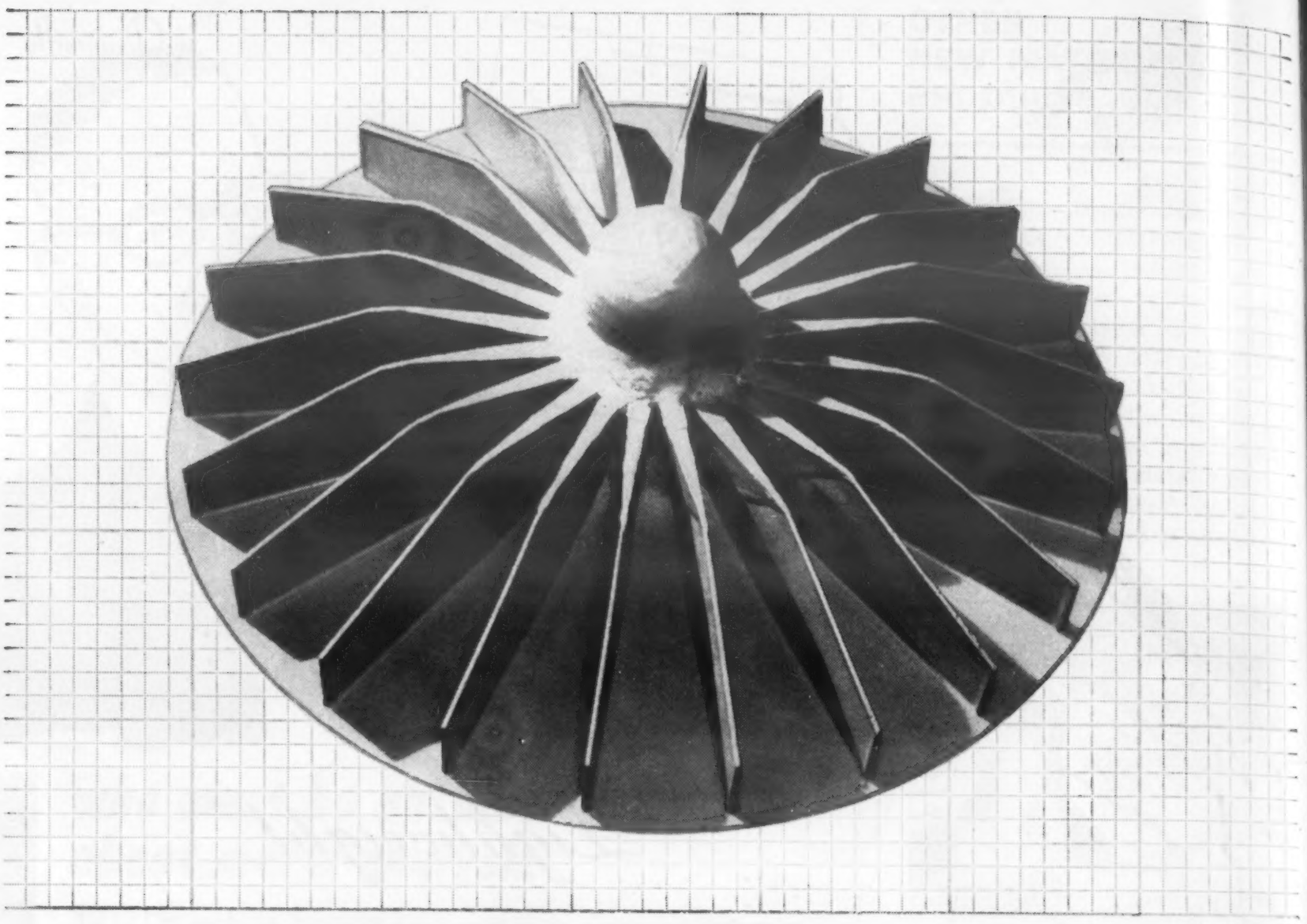

22-inch Diameter Wheels Investment Cast . . . at a 50% Saving

Turbine wheels, 22 inches in diameter and weighing close to 100 pounds, are now being mass-produced by HAYNES' precision-investment-casting process. The wheels are made of stainless steel and are used in the turbocharger section of a compressor. At one time a lengthy profile machining operation was needed to shape the intricate blades. Investment-casting eliminated this operation and cut production costs in half.

The savings realized on this wheel are typical of the many economies made possible by HAYNES' precision-investment-casting process. This modern mass-production method eliminates many machining, grinding, and assembling operations. Intricate contours, odd-shaped cavities, and thin edges can all be cast to size. Two or more parts can be designed and produced as one integral part. In most instances, an investment-cast part can be placed in operation as soon as it is delivered.

For information on how you can use HAYNES' investment-casting process to keep production costs down, write to any of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

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"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

For more information, turn to Reader Service Card, Circle No. 363

are required, a short cure time is necessary between layers; a contrasting color can be used for layer identification. The new material is also said to provide an exceptionally glossy finish. It has the same degree of toughness, and chemical and abrasion resistance as Miccrosol E-1003.

Coated Nylon Fabric Stronger Than Canvas

Vinyl or neoprene-coated nylon fabrics are now available from *C. R. Daniels, Inc.*, Daniels, Md. Called Dantex, the material is said to be more than five times as strong as the same weight of standard treated canvas. Also, the fabrics are unaffected by oil, grease, most acids and temperature extremes. They can be sewn or cemented, are waterproof and can be made flame resistant. A range of colors, as well as white and aluminum, are currently available in all weights.

Tool Plastics Have Good Wear Resistance

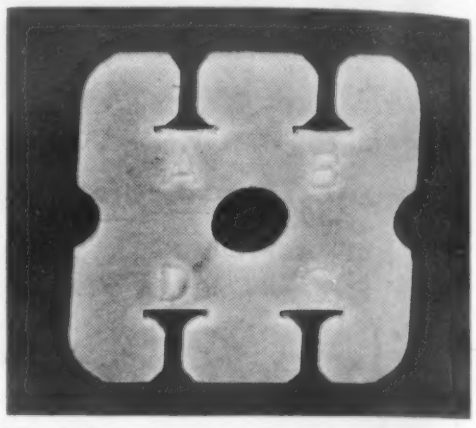
Three epoxy resin formulations particularly designed for use in plastics tools where wear or abrasion is anticipated have been developed by *Marblette Corp.*, 37-21 Thirtieth St., Long Island City 1, N. Y. They are a die laminating resin, #602, a surface casting resin, #612-B, and a surface coating resin, #613. All three formulations are said to have a high degree of abrasion resistance and can be cured at room temperature.

Laminating resin #602, which can be stored unrefrigerated for long periods, has low viscosity and wets fibrous glass instantly. High dimensional stability and good chemical resistance are coupled with high abrasion resistance for applications such as draw dies,

OTHER NEW MATERIALS, PRODUCTS

routing fixtures and foundry patterns.

The heavy consistency of coating resin #613 permits it to be spread evenly without danger of run-off on vertical surfaces. Both #613 and #612-B have a Rockwell hardness of M98.



Warm-Punching Phenolic Laminates

Two grades of phenolic laminates which require a moderate degree of heat for accurate punching have been marketed by *Taylor Fibre Co.*, Norristown, Pa. Designated Grade XP-240 and XXP-241, the laminates are a light natural color and, though they need some heat for punching complicated shapes, they require much less than comparable NEMA grades. According to Taylor Fibre, Grade XP-240's physical and electrical qualities exceed NEMA specs for Grade P, while Grade XXP-241 exceeds NEMA specs for Grade XXP.

Epoxy Compound for Cable Splicing

A hard-setting epoxy compound, packaged in a compartmentalized polyethylene container, has been marketed to permit field insulation and weatherproofing of electrical cable splices. Called Thoxene Clamp-Coat, the material is ready to use as soon as its two components are mixed in the bag. Developed by *Woodmont Products, Inc.*, Huntingdon Valley, Pa., the

☒ Check list for LITHIUM Researchers—No. 2

Lithium has enabled industry after industry to achieve over-all savings through shortcuts, reduction of waste, improvement of end-product, and simplification of operating procedures. Check your field of interest in Lithium below. If you are interested in a specific application relative to Lithium not indicated in the checklist, note the fact in the form furnished, attach it to your letterhead and send it to us. Our research laboratory will look into the matter for you.

LITHIUM COMPOUNDS

LITHIUM CARBONATE

Uses:

- ☐ Porcelain enamels
- ☐ Pottery glazes
- ☐ Special glasses
- ☐ Pharmaceutical chemicals
- ☐ Lithium salts
- ☐ Heat treating salts

LITHIUM HYDROXIDE

Uses:

- ☐ Storage batteries
- ☐ Gas absorption
- ☐ Pharmaceutical chemicals
- ☐ Multi-purpose greases
- ☐ Lubricating oils
- ☐ Lithium salts

LITHIUM CHLORIDE

Uses:

- ☐ Gas absorption
- ☐ Air conditioning
- ☐ Welding rods
- ☐ Brazing fluxes
- ☐ Lithium metal
- ☐ Heat treating salts
- ☐ Deicer fluid

LITHIUM COBALTITE

Uses:

- ☐ Porcelain enamels (ground coats and colored cover coats)

LITHIUM BROMIDE

Uses:

- ☐ Air Conditioning
- ☐ Pharmaceuticals
- ☐ Gas absorption

LITHIUM NITRATE

Uses:

- ☐ Refrigeration
- ☐ Heat treating salts

LITHIUM MANGANITE

Uses:

- ☐ Porcelain enamels (ground coats for kitchenware, refrigerators, stoves, etc., cover coats for colored ware)
- ☐ Semi-conductors

LITHIUM SILICATE

Uses:

- ☐ Titanium porcelain enamels
- ☐ Glazes for sanitary ware
- ☐ Pottery glazes

LITHIUM TITANATE

Uses:

- ☐ Titanium porcelain enamels
- ☐ Ceramic glazes
- ☐ Electric porcelains

LITHIUM ZIRCONATE

Uses:

- ☐ Porcelain enamel ground coats
- ☐ Titanium porcelain enamel cover coats
- ☐ Ceramic glazes
- ☐ Electric porcelains

LITHIUM ZIRCONIUM SILICATE

Uses:

- ☐ Ceramic glazes
- ☐ Electric porcelains

LITHIUM ALUMINATE

Uses:

- ☐ Flux in highly refractory enamels

LITHIUM (META)BORATE

Uses:

- ☐ As a flux in enamel cover coats

LITHIUM MOLYBDATE

Uses:

- ☐ As smelter or mill addition in white enamel cover

I am interested in Lithium_____ for
(Compound, Metal or Derivative)

the following application:_____

_____

_____

_____

Technical Data Sheets are available for every compound in the checklist. They will be sent as checked above.

. . . trends ahead in industrial applications for Lithium

LITHIUM CORPORATION OF AMERICA, INC.
2690 RAND TOWER
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MINES: Keystone, Custer, Hill City, South Dakota • Bessemer City, North Carolina • Cat Lake, Manitoba • Amos Area, Quebec • BRANCH SALES OFFICES: New York Pittsburgh • Chicago • CHEMICAL PLANTS: St. Louis Park, Minnesota • Bessemer City, North Carolina • RESEARCH LABORATORY: St. Louis Park, Minnesota

For more information, turn to Reader Service Card, Circle No. 360

OTHER NEW MATERIALS, PRODUCTS

material is applied to cable splices and allowed to harden for periods of 2½ to 3 hr, depending on ambient temperature. The mixture contains no solvents, and coatings up to ⅛ in. thick can be applied without dripping off.

The compound utilizes Epon epoxy resins and is said to have high resistance to moisture, abrasion and impact, and a high degree of adhesion to wires and clamps. Mechanical and electrical properties of the cured compound are as follows:

Dielect Str, short time, v/mil	450
Vol Resist, ohm cm	4.2×10^{16}
Surf Resist, ohm	1.3×10^{13}
Dielect Const (1 kc)	5.0
Dissip Fact (1 kc)	0.059
Water Absorp (24 hr), %	0.51
Elong, %	48
Shore D Hardness	58
Tensile Str, psi	900

Precision Nylon Balls

Nylon balls held to tolerances of ±0.002 in. on diameter and ±0.001 in. on sphericity are now available from stock in 14 standard sizes ranging from ⅛ to ¾ in. dia. Marketed by *Industrial Tectonics, Inc.*, Ann Arbor, Mich., the balls are made from Type FM-10001 nylon and are light in weight and resistant to corrosion and wear. Physical properties of the material include tensile strength of 10,900 psi, modulus of elasticity of 400,000 psi, Rockwell hardness of R118, coefficient of thermal expansion of 5.5×10^{-5}, deformation of 1.4% at 122 F

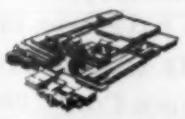
RICHARDSON

helps improve molded auto parts

Each of the molded parts pictured here had specifications which called for special materials often with unusual properties. All called for creative design approaches, both by customer and Richardson.

Richardson engineers, specialists in both molded and laminated plastics, will welcome the opportunity to help you. Write or phone for additional information.

THE RICHARDSON COMPANY
FOUNDED 1858
2782 Lake St., Melrose Park, Ill. (Chicago District)


MELROSE PARK, Ill.


INDIANAPOLIS, IND.

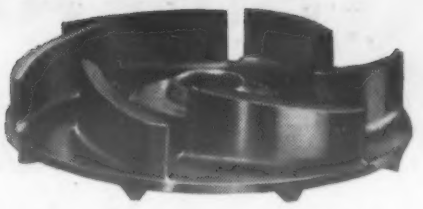

NEWNAN, GA.


OGDEN, UTAH

SALES OFFICES IN PRINCIPAL CITIES

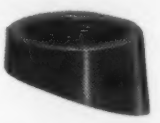

NEW BRUNSWICK N. J.


TYLER, TEXAS

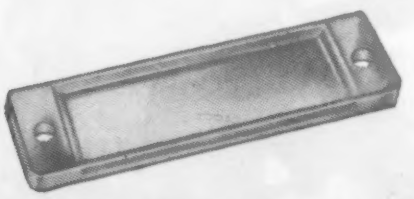


. . water pump impeller A special moisture resistant phenolic was specified for this part which must withstand the extremes of both high heat and intense cold, as well as strong torque action plus corrosion and cavitation resulting from the circulation of water in the car's cooling system.

. . timing gear The molded blank of this gear had to have high flexural characteristics . . also a good bond in the laminate section for ease in cutting gear teeth, and to insure necessary tooth strength. The manufacturer and Richardson developed a new material with high heat resistance. Result: Fine flexural strength in the web section . . more quiet operation . . . easier fabrication . . . easier assembly . . . *tripled gear life!*



. . radio antenna mast base This part had to have good surface appearance, high impact strength, high dielectric strength, and at the same time be weather resistant. A black phenolic material with an attractive high gloss finish was recommended.



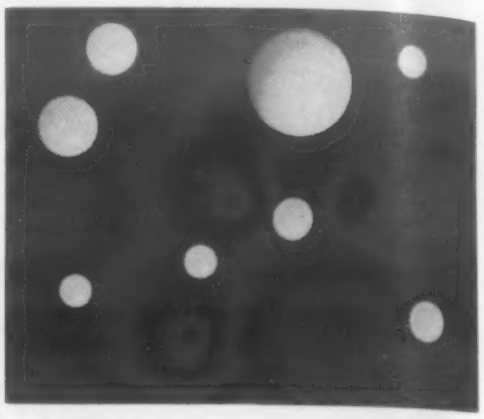
. . dashboard light lens Originally this part was designed as a clear lens. Later, when the specifications were changed to call for a translucent lens, the customer suggested that either the mold, or the clear parts, be sandblasted. . either process would have increased costs. Richardson suggested, instead, a special light-transmitting polystyrene. Result: 15% reduction in lens cost.

RICHARDSON PLASTICS

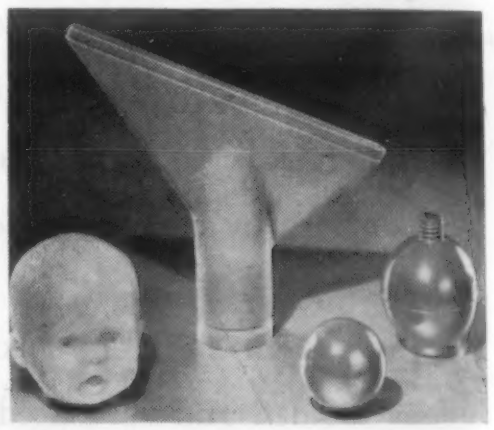
MOLDED AND LAMINATED

For more information, turn to Reader Service Card, Circle No. 387

OTHER NEW MATERIALS, PRODUCTS



under a load of 2000 psi, heat distortion temperature of 400 F under a 66 psi load, water absorption of 1.5%, and specific gravity of 1.14. Typical applications include use in bearings, pumps, check valves and instruments.



Hard, Tough Plastisols

A series of plastisols that show durometer readings on the A-2 Shore scale of 95 to 120, as well as high tensile strength, has been developed by *Munray Products, Inc.*, 12383 Crossburn Ave., Cleveland 11. The high hardness permits their use in many products for which plastisols have been impractical in the past. Called Rigo-Plas, the materials are "dry" and non-blooming. They can be formed by any of the conventional plastisol-forming methods, though they are particularly recommended for use in the rotational casting process. Elongation of the materials at 130 F is 200 to 250%. According to Munray, the hardest Rigo-Plas material is more than 25% harder than other rigid plastisol formulations.

TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

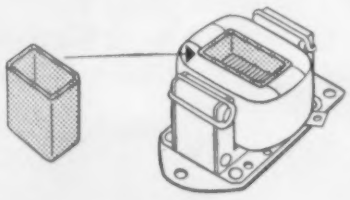
TAYLOR FIBRE CO.

Plants in Norristown, Pa. and La Verne, Calif.

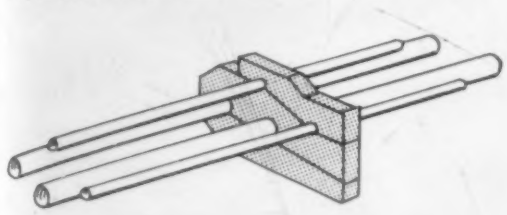
PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

Tips for designers

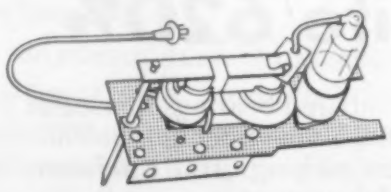
Terminal strips for high-precision electronic instruments benefit from the excellent insulating properties of Taylor XXXP-301 hot-punch laminate.



Coil forms for this solenoid have to operate at high temperatures . . . an ideal application for Taylor glass melamine laminate.



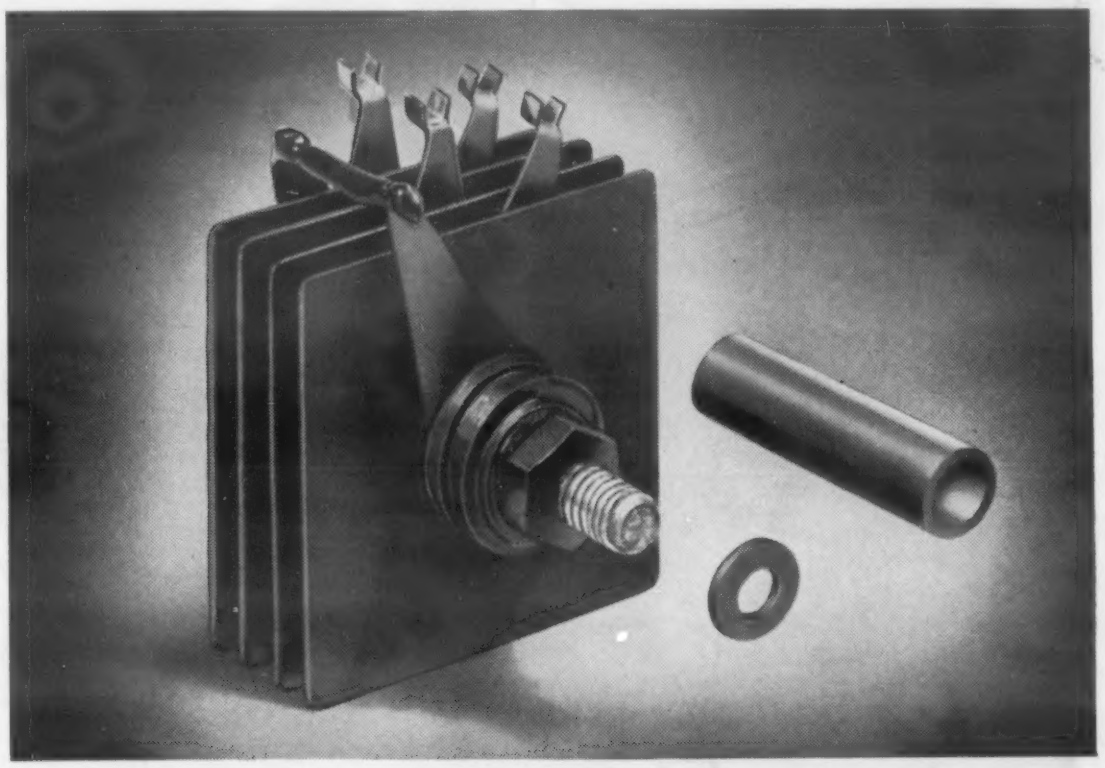
Fuel line clamp for a fighter airplane's "pipe-line" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.



Base plate for high-voltage TV component, punched from Taylor canvas melamine laminate, has high dielectric strength and arc resistance.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Low-flow under physical load is an important characteristic of the Taylor Grade 353 washer used in this selenium rectifier. The Taylor Grade XX-10 tube provides dependable, long-lasting insulation for the current-carrying plates.

Electrical and physical stability *recommend Taylor laminates*

Dozens of different grades of Taylor laminates offer the designer and the production man a variety of combinations of electrical and physical properties for a wide range of product applications.

And very important . . . but often overlooked . . . is the degree to which these Taylor laminates maintain their original characteristics, over long periods of time and under severe operating conditions. You can have performance to fit your requirements . . . performance with stability . . . when you use Taylor laminates.

Included in this broad selection of materials are paper, fabric and glass bases . . . phenol, melamine, silicone and epoxy resins. Within the complete line there is the combination you need, to improve the performance of your present product or to help move a new product into practical and economical production.

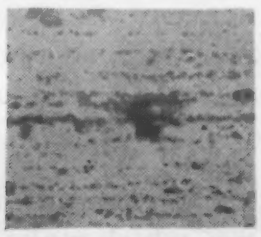
They are available in several forms, too, which make for greater fabrication efficiency . . . sheets 49″ by 49″, and tubes and rods in a wide range of sizes.

Whenever you are looking for a laminate . . . and particularly when the specifications include stability . . . it will pay you to check with Taylor first. To help you in your selection, Taylor offers the services of its engineering staff as well as the facilities of its fabricating division. Call on Taylor for a consultation on your specific requirements.

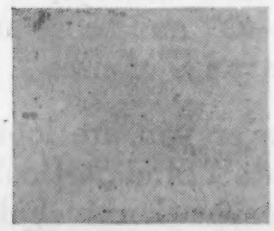
For more information, turn to Reader Service Card, Circle No. 368

Vacuum-melted steel boosts bearing life 620%

Photomicrographs showing typical improvement in cleanliness.



Air melted Halmo X100



FERROVAC Halmo X100

Not long ago, an anti-friction bearing manufacturer compared bearings fabricated from air-melted Halmo (1 vanadium, 0.65 carbon, 5 chrome, 5 molybdenum, balance iron) steel with bearings of the same steel made by vacuum melting. Test conditions were identical: heavy overload–high speed–400F–oil jet lubrication.

Results were decisive: *maximum* life of the air-melted bearings was 150 hours . . . the *average* life of the vacuum-melted or FERROVAC® Halmo bearings was 1080 hours–6.2 times better!

This marked difference is explained by the photomicrographs at the left. Note the air-melted alloy. Here inclusions are warnings of early bearing failure.

But note the absence of these impurities in the FERROVAC Halmo steel. They were literally sucked out of the molten metal during the vacuum process. The result is cleaner steel that's stronger, tougher, more resistant to wear and fatigue. And, in bearing applications, this means substantial reduction of the scatter band (spread of failures) . . . *virtual elimination* of early failures.

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted metals, now has them available in tool, high-speed, stainless and alloy steels–in most sizes and grades–as well as special ferrous and nonferrous alloys. For help with metal problems that vacuum-melted alloys might solve, please write us, describing them in as much detail as possible. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, New York.*

VMC

VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

For more information, turn to Reader Service Card, Circle No. 321

CONTENTS NOTED

A digest of papers, articles, reports and books of current interest.

This Month:

- *Engineering plastics*
- *Anodic coating for magnesium*
- *New textile system*
- *Nodular iron for valves*
- *Creep in stainless*

Conferees Discuss Latest in Plastics Engineering

Though a great deal has been learned about plastics engineering in the relatively short life of the plastics industry, there is a tremendous amount still to be learned. This fact was again emphasized at the Twelfth Annual Technical Conference of the Society of Plastics Engineers held recently in Cleveland. Papers were presented on properties of plastics, forming techniques for plastics, reinforcing of plastics, research and development, plastics foams, and designing with plastics. Some papers stated accomplished fact, some presented theory. Almost all stressed the need for more information.

Some of the more interesting papers from the standpoint of specifiers of plastics materials were a paper on non-glass reinforcing materials for plastics, and two papers on impact testing of plastics.

Non-glass fibers

If the strong financial incentive and concentrated research which has backed development of glass reinforcement were applied to other possible reinforcing materials, we would have today a well developed market and know-how for those other reinforcing materials, according to Dr. Johan Bjorksten, President of Bjorksten Research Laboratories.

In his paper, Bjorksten pointed out possible advantages of using materials such as cotton, nylon, Dacron, Orlon and asbestos. Other possibilities would be tetrafluoroethylene or sisal, hemp, ramie and jute. Rather than detracting from the importance of glass, the author emphasized the possibilities of broadening the range of properties and reducing the cost of reinforced plastics.

Listed as advantages of cotton were: widespread availability and low cost, durability, higher elasticity than glass, lighter than glass (about 50% lighter), and good bulking and insulating qualities. Disadvantages, on the other hand, include poor moisture resistance, poor resistance to heat, and poor resistance to strong acids and alkalies.

Nylon, Dacron and Orlon were described as tough, resilient synthetic fibers with high tensile strength. They also have excellent electrical properties, good chemical resistance, lighter weight than glass, and good bonding properties with resins. Relatively high cost is their primary drawback. The author points out that if the moisture resistance of rayon could be overcome by sizing or finishing procedures, its light weight and high strength could be advantageously put to work.

Vegetable fibers such as sisal, hemp, ramie and jute have not been used extensively because they are not easily wetted by resins and are quite readily broken down during processing. They are also high in cost, less available than other fibers, and they have a high degree of water absorption. Again, development of proper sizing procedures might greatly improve moisture resistance and compatibility with resins.

Advantages of asbestos fiber reinforcing were summarized as: resistance to high temperatures, non-flammability, low cost, good chemical resistance, good water resistance, and the ability to impart a high flexural modulus to laminates. Disadvantages are said to be brittleness and poor resistance to abrasion, high specific gravity, and poorer electrical properties than cellulose paper or glass. (For more information on asbestos reinforced plastics laminates see M&M, February, 1956, p. 103).

The author pointed out that though each of these non-glass reinforcing materials has certain disadvantages, research and experimental work could minimize or eliminate most of them, thereby allowing the properties of each material to be used to advantage.

Impact testing

Two papers suggested modifications of standard impact tests as applied to plastics. One paper prepared by workers at Monsanto suggested that a more accurate estimation of "toughness" of thermoplastic materials can be gained by 1) carrying out Izod impact tests with at least two different radii notches, and 2) incorporating a falling ball impact test. The second paper, prepared at du Pont, described advantages of a simple modification of the Izod test which satisfies the need for impact testing under clear-cut tensile stresses.

1. In the first paper, C. H. Adams, B. G. Jackson and R. A. McCarthy of Monsanto pointed out that there are a number of characteristics of a material which are intimately related to that material's ability to withstand shock loads. These are damping ability, rigidity, strength and ductility. However, it is virtually impossible to determine the individual importance of each

of these characteristics. Though the authors feel that the Izod test does provide an estimate of impact resistance of a material, they believe it is too severe and restricted.

Several variables affect the results of the tests and should be taken into consideration. They are:

Test speed. The authors found that the actual test speed developed at the root of the standard 0.010-in. notch is much higher than normally encountered by these materials when shock loaded in end-use applications. The pronounced effect of changing the test speed by altering the radius of the notch led to the conclusion that it would be advisable to use more than one test speed in determining Izod values. Therefore, the authors recommend that a minimum of two radii be used for each material tested.

Test temperature. Tests at varying temperatures need only be carried out for those materials which are to be used at abnormal temperatures.

Sample preparation. Injection molding has been the standard method of preparing thermoplastic test samples. The authors found that the orientation within injection molded material results in definite anisotropic strength characteristics which the Izod test fails to take into consideration. The authors feel that a drop ball test more closely approximates impact loading encountered in field applications, and also takes into account any anisotropy in the specimen.

The drop ball tests consists of dropping a 66-g steel ball from various heights on tile-type samples supported on a 4x4-in. (interior dimension) wooden frame. The end point of the test was considered to be reached when 80% of the specimens failed, as shown by visible cracks. The major advantage of the technique lies in the fact that the finished article is evaluated in a manner that does not predetermine the direction of fracture.

In summing up, the authors recommended that standard ASTM specimens prepared by injection molding should be evaluated by Izod impact at a minimum of two notch radii. Edge-gated wall tile specimens (or compression moldings of similar configuration) should be evaluated by falling ball technique and also by Izod impact on specimens cut parallel and normal to direction of orientation. These tests, supplemented by tensile property measurements at two widely separate loading rates, should give an accurate estimate of toughness level.

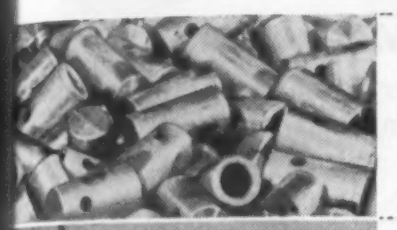
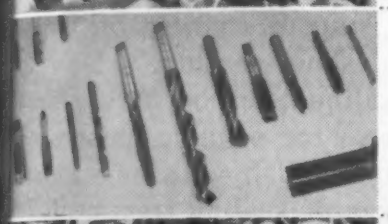
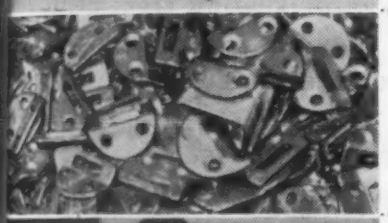
2. In the second paper, C. G. Bragaw, Jr., of du Pont described a simple modification of the Izod test to provide a tensile impact test which can be used on injection and compression moldings, films, filaments and machined structures. The one test can evaluate on a common basis materials having a wide range of rigidity—from soft rubber and warm polyethylene to steel and glass.

The method makes use of four small metal adapters which are added to the Izod impact tester. The specimen is held horizontally by a vise and a crosshead which maintains the specimen in tension. When the pendulum is released, instead of striking the vertical specimen as in conventional tests, it strikes the crosshead holding the horizontal specimen, breaking the specimen in tension. A small correction must then be made for kinetic energy of toss due to flying off of the specimen-end and crosshead.

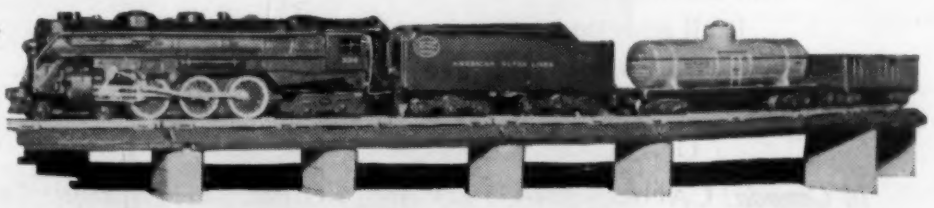
According to the author, the test has the following advantages: 1) It allows materials, regardless of stiffness, to be rated on a common basis. 2) Because lateral rigidity is not required, film specimens can be used. Also, much smaller samples of developmental polymers can be tested. 3) Due to specimen geometry, im-

Can a Steam Atmosphere Furnace Save You Money?

There's a good chance it can if you heat treat any of a wide variety of ferrous parts. Here's a check list to show you why.

	PRODUCT	MATERIAL	ADVANTAGE
	Cams, bearings, valve tappets, pistons, piston rings, etc.	Cast iron	Wear resistance improves
	Twist drills, taps, punches, reamers, counter bores, etc.	High-speed tool steel	Tool life increased
	Saw blades, machine parts	Steel	Improved bonding surface for paint or lacquer prevents chipping and cracking
	Business machine, sewing machine, gun parts, bolts	Steel	Clean, safe, cheap method of blueing
	Bearings, bushings, pistons, toy parts, etc.	Powdered iron	Hardness and compressive strength improved

A. C. Gilbert Co. inexpensively achieve that uniform, wear resistant, blue-black finish on the undercarriages of scale-model trains by heat treating in an L&N Steam Homo furnace.



Complete equipment for steam atmosphere heat treating consists of a Steam Homo® furnace and L&N temperature control panel. Both furnace and instrument panel are shipped completely assembled ready for installation in your production line. Furnaces are available in a variety of sizes to suit your particular application. For complete information just write us at 4925 Stenton Ave., Phila. 44, Pa., and ask for Catalog TD2-620.

LEEDS NORTHRUP
instruments — automatic controls • furnaces

For more information, turn to Reader Service Card, Circle No. 326

pact strength can be evaluated apart from notch sensitivity. If effects of notching or abrasion are to be evaluated, suitable specimens can be prepared. 4) It lines polymers up in an order more compatible with that which experience has established as the order of impact strengths encountered in practice.

Cr-22 Anodic Coating for Magnesium

Short treatment times (about 12 min) and low electrolyte costs are combined with excellent protective properties in Cr-22, the newest anodic coating for magnesium. The coating, which is non-alkaline, can be used either as a base for organic finishes or as a final finish with or without an inorganic sealing treatment. It is far smoother than any of the high voltage anodic coatings currently used for magnesium.

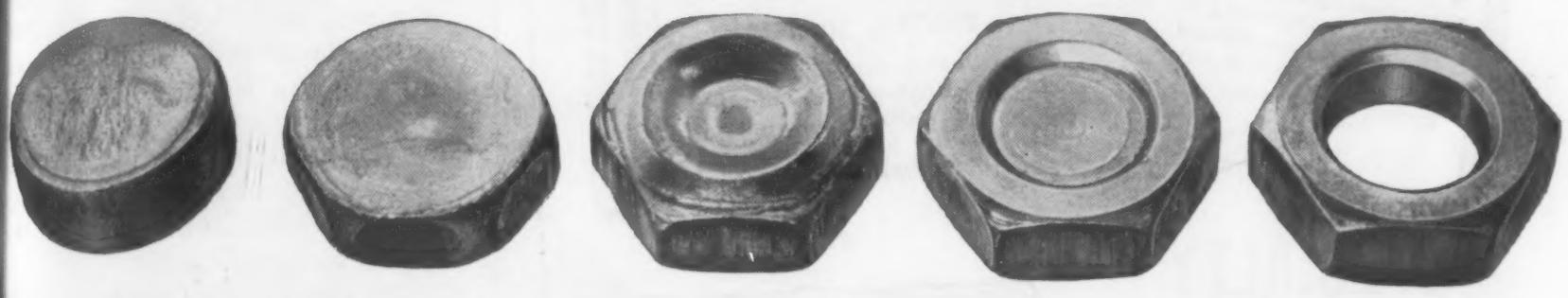
Characteristics of the coating and methods of application were detailed in an article in last December's *Metal Finishing* by W. McNeill, of the Frankford Arsenal, where Cr-22 was developed.

Coating characteristics

The coating has been applied successfully to FS, J, C, H, ZK-60, ZRE, Z5Z and M alloys, though application on M alloy can be troublesome. FS panels having aluminum rivets in them have been coated successfully. In appearance, Cr-22 is a fine-grain green coating resembling unglazed ceramic-ware in texture. It normally has a surface roughness of 80 to 100 rms, or higher if the coated surface is rough. The color can be deepened through olive drab to near black by increasing chromate concentration in the bath. Increasing fluoride concentration causes a lightening of color, and also tends to decrease surface roughness to 60 to 70 rms.

Thickness of the coat varies with temperature, but at 200 F it has a total thickness of about 1

YOUNGSTOWN
STEEL ROUNDS
used in manufacture of quality RB&W nuts



Russell, Burdsall & Ward Bolt and Nut Company pride themselves on the strength of their bolts and nuts. Justifiably, too, because they fabricate tremendous quantities of nuts from Youngstown Scrapless Nut Quality Steel. Not an ordinary steel, each step in making this Youngstown steel, from ore to the finished product, is closely controlled.

That's why, when nut formers punch and pound it, and when threading machines give it another going over, a nut made of Youngstown Steel comes through a winner. This material is free of injurious seams and also machines cleanly in the threading operation.

When you order Youngstown Scrapless Nut Quality Steel, either in Bar, Rod or Wire form, you can be sure it will be held to the right tolerances. Nothing less than perfection is the Youngstown policy.

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Five stages of nut making with Youngstown Scrapless Nut Quality Steel Rounds. Made by Russell, Burdsall & Ward, the end result shows what can be done with quality steel. The production machines are running smoothly at the Russell, Burdsall & Ward plants. Nuts by the millions are produced daily. Some are shown in the container in the foreground.

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For more information, turn to Reader Service Card, Circle No. 318

CONTENTS NOTED

mil and adds approximately 0.75 mil to the surface of FS alloy. Breakdown voltage of the coating is normally about 500 to 600. Hardness is difficult to measure, but the coating will abrade copper and mild steel. Adhesion has been measured by cementing metal disks to opposite sides of coated panels. An average force of 2500 psi is required to separate the coating from the magnesium by pulling normal to the panel surface.

To test the usefulness of Cr-22 coatings as a base for paint, coated panels were painted with one coat of zinc chromate primer, scribed, and placed in 20% salt spray. After 1500-hr exposure all specimens were intact. Continuing the test to 5000 hr resulted in almost no undercutting of the paint and only slight pitting.

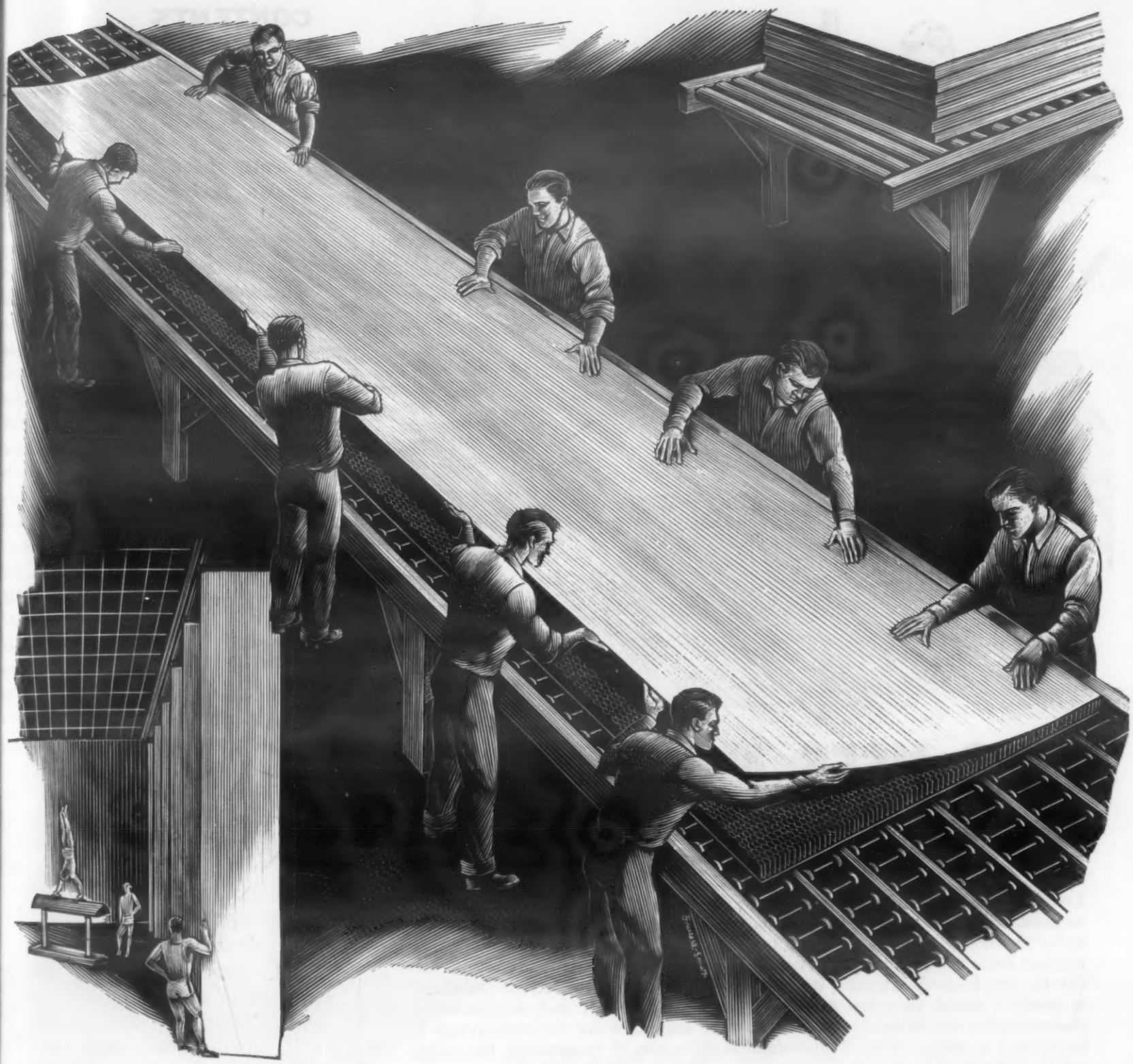
Corrosion resistance

Cr-22-coated 4x6-in. FS-1 alloy panels usually show no corrosion after 48 hr exposure in 20% salt spray. After 120 hr exposure, panels of this size generally average from one to five pits. Sealing the coating in a sodium silicate solution produces a marked increase in corrosion resistance. After 420 hr exposure to 20% salt spray, sealed panels of the type and size described above average four pits each.

During tests to determine protection from galvanic corrosion, treated specimens were coupled with 2024 aluminum and 18-8 stainless steel. No corrosion occurred after 5 hr exposure in 20% salt spray. After 24 hr exposure, aluminum couples were not corroded, but the coating in contact with steel couples was discolored. No heavy corrosion products formed.

Textured Yarn: New Textile System

A third major system of textile materials, morphologically different from both staple and continuous-filament systems, has



Bond 24-foot sandwich panels without jigs, clamps, or curing ovens

The assembly line in the picture is turning out 24-foot aluminum-honeycomb sandwich panels for use as gymnasium partitions. The adhesive being used is Armstrong D-253. With this remarkable adhesive, you can bond sandwich panels of any size that you can handle . . . without the need for costly jigs, clamps, or curing ovens.

Here's how the job's done: spray or roll D-253 on skin sheets and core, force dry for a minute or two, and assemble your sandwich. One pass through a pinch roll produces an instantaneous, permanent bond. Your finished panel is ready for further processing or immediate shipment.

D-253 is a thermoplastic adhesive with exceptionally high dead load strength and flexibility. In an aluminum-honeycomb panel, for example, where the expansion of the metal would be greater than that of the core, the D-253 bond is strong enough—and flexible enough—to withstand such movement.

Armstrong D-253 is not restricted to bonding aluminum to honeycomb, of course. This versatile adhesive may be used to fasten plastic laminates, plywood, stainless steel, hardboard, and many other materials to different cores.

For more information on D-253 and other Armstrong adhesives write for our Adhesives Manual. It's free to industrial users. Armstrong Cork Company, 8003 Dunbar Street, Lancaster, Pennsylvania. In Canada, 6911 Decarie Blvd., Montreal 29, Quebec.

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CONTENTS NOTED

recently been developed. Called Taslan textured yarn, the material consists of a continuous multifilament yarn in which every filament is formed into small randomly spaced loops several times per inch of length. Thus a 34-filament yarn might have as many as 70 to 80 loops per inch. Straight sections of fiber between loops are locked together by twist to form a stress-bearing core which is responsible for tensile strength. Both ends of each loop are mechanically locked into the stress-bearing core by friction so that as the yarn is stretched, the loops maintain their form up to and past the break elongation of the yarn. The loops contribute both a dry staple-like hand to the surface, and bulk and openness to the interior of fabrics.

The material was described in a paper by J. T. Rivers, Jr., of du Pont, presented before the Diamond Jubilee Semi-Annual Meeting of the American Society of Mechanical Engineers last June and published in *Mechanical Engineering* in January.

Yarn characteristics

The texturing process can be applied to practically any kind of yarn. Specific characteristics of end products vary with the fiber used. In comparison with fabrics made from continuous filament yarn, fabrics made from Taslan generally have greater bulk, drier hand, higher covering power and a more subdued luster. Compared with spun staple fabrics, they have equal or lower bulk density, a drier and crisper hand, improved freedom from pilling and fuzzing, and greatly improved uniformity.

Tensile properties of textured yarns lie between those of continuous-filament yarn and staple yarn of equivalent fibers. In general, tenacity and modulus are lower than in continuous-filament yarn and higher than in spun yarn. Elongation is higher than in continuous-filament and lower than in spun yarn. Fabrics made from Taslan have equal or lower bulk

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densities than spun-yarn fabrics and have substantially lower bulk densities than continuous-filament fabrics. There is not much difference in crease recovery between the three types of fabrics.

Varying properties

Properties of fabrics made from textured yarn can be varied by changing filament denier, cross section, twist, or loop size and frequency. Reducing filament denier produces greater softness, whereas increasing filament denier increases crispness. Changing from a round to a ribbon cross section produces a harsher fabric with drier hand and more surface tooth. Twist performs an important function in anchoring loops in the textured-yarn bundle. Proper choice of turns per inch is important in obtaining desired characteristics such as bulk or fullness and in producing added character in the resultant fabric. In general, as loop size increases, Taslan yarn and fabric decrease in bulk, lose dryness of hand and become softer. As loop frequency increases at constant loop size, fabrics become more bulky and drier in hand. At the same time they gain in covering power, and surface luster is reduced.

Nodular Iron Valves

Initial impact and bending tests indicate that in certain valve applications nodular iron will perform as well as, or better than, commercial cast steel. Current specifications of ASME Boiler and Unfired Pressure Vessel Code, 1952, require either high-test cast iron or steel to be used in valves, flanges and pipe fittings at pressures in excess of 160 psi and temperatures in excess of 450 F. Though a great deal of work must still be done, nodular iron valves appear to have sufficient shock resistance and ductility to avoid brittle fracture under these conditions. In addition, nodular iron has a high degree of resistance to corrosive action of certain fluids.

Materials and tests

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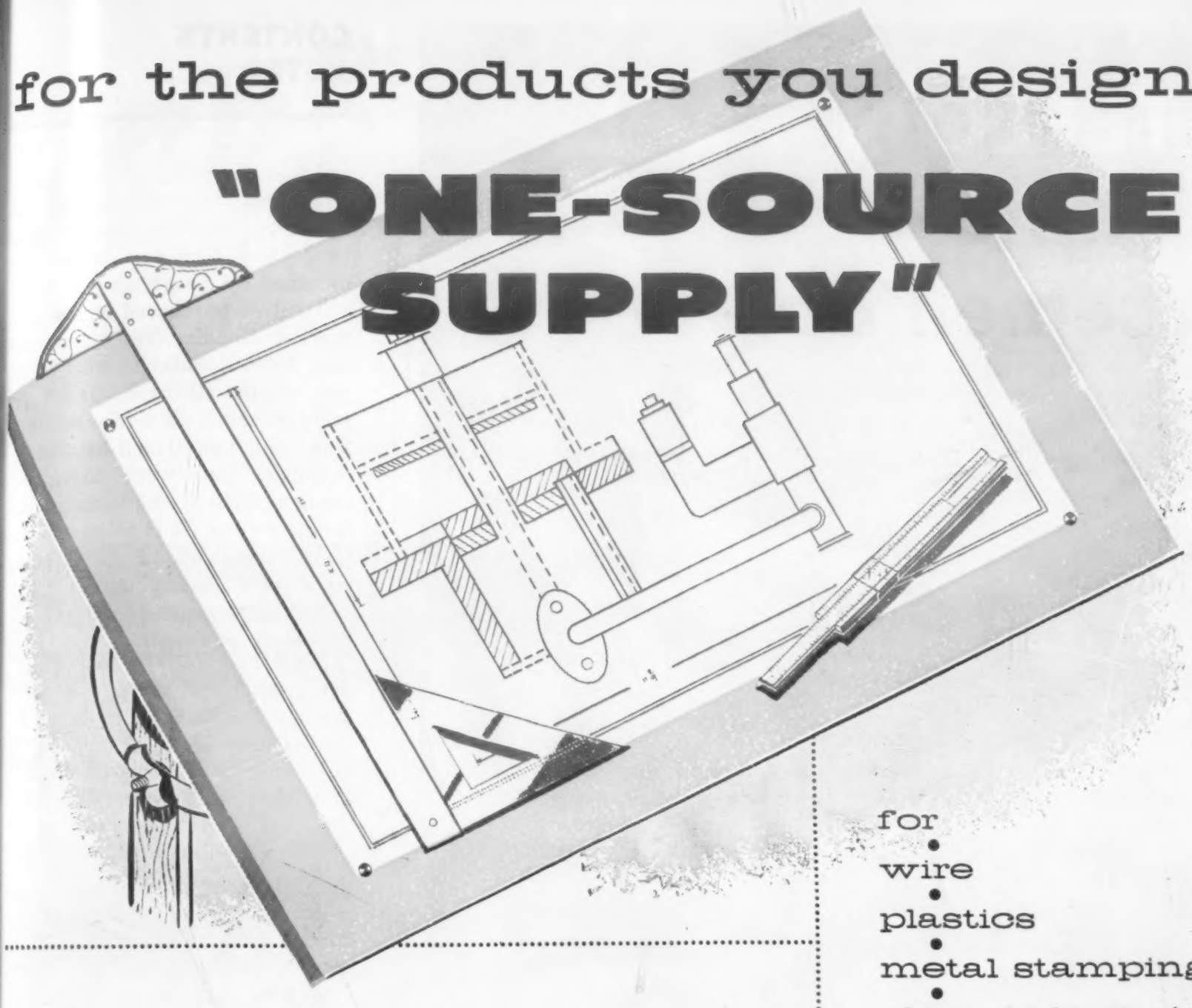

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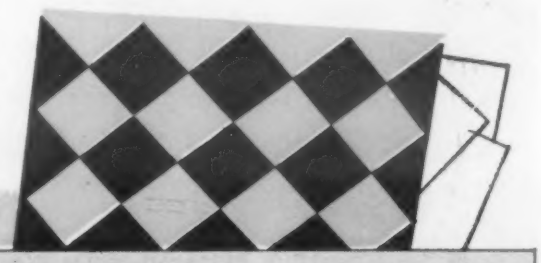

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CONTENTS NOTED

ard 6-in. flanged gate-valve bodies. Gray cast iron bodies were selected at random from regular production. Cast steel bodies were obtained by disassembly of standard valves purchased on the open market. Nodular iron valves were cast from a material with 72,000 psi tensile strength, 54,000 psi yield strength, 20% elongation in 2 in., and 155 Brinell hardness.

Impact tests were carried out using a 2840-lb skull-cracker ball dropped from 35 ft at an ambient temperature of 40 F. Bending tests were carried out at 900 F on all three types of valves.

Summary of results

No brittle failure occurred under impact for the cast steel or the nodular iron bodies. Under repeated drop tests, damage to the nodular iron valve body was less than that to the cast steel body. The cast iron shattered in a brittle manner under relatively low impact.

Load carrying capacity of the ductile iron valve at 900 F exceeded that of the cast steel valve. Though a tear started in the former after considerable deformation, the fracture did not propagate. The cast steel valve suffered so much plastic distortion that the test could not be continued to fracture. Cast gray iron failed catastrophically at relatively low loads.

Water quenching of cast iron valves from 900 F under load did not induce failure from thermal stresses. The investigators therefore concluded that other materials would not be affected by this treatment if heating temperatures were below the critical. Physical properties of ferritic nodular iron of the composition used in these tests are not affected by drastic quenching until the temperature exceeds 1400 F.

Improving Creep Rupture of 347 Stainless

Cold working and warm working are recognized methods of improving both low temperature

CONTENTS NOTED

and high temperature properties of stainless steels, as well as other metals and alloys. However, still unknown are the relative advantages provided by such treatments for specific stainless steel compositions. As one step in compiling this data type 347 columbian stabilized stainless steel has been cold worked up to 60%, the object being to determine resulting benefits for the alloy at service temperatures ranging from 1200 to 1500 F. Results of the work were reported in a paper by N. J. Grant, A. G. Bucklin and W. Rowland, of Massachusetts Institute of Technology. The paper was presented at the 37th Annual Convention of the American Society for Metals last October.

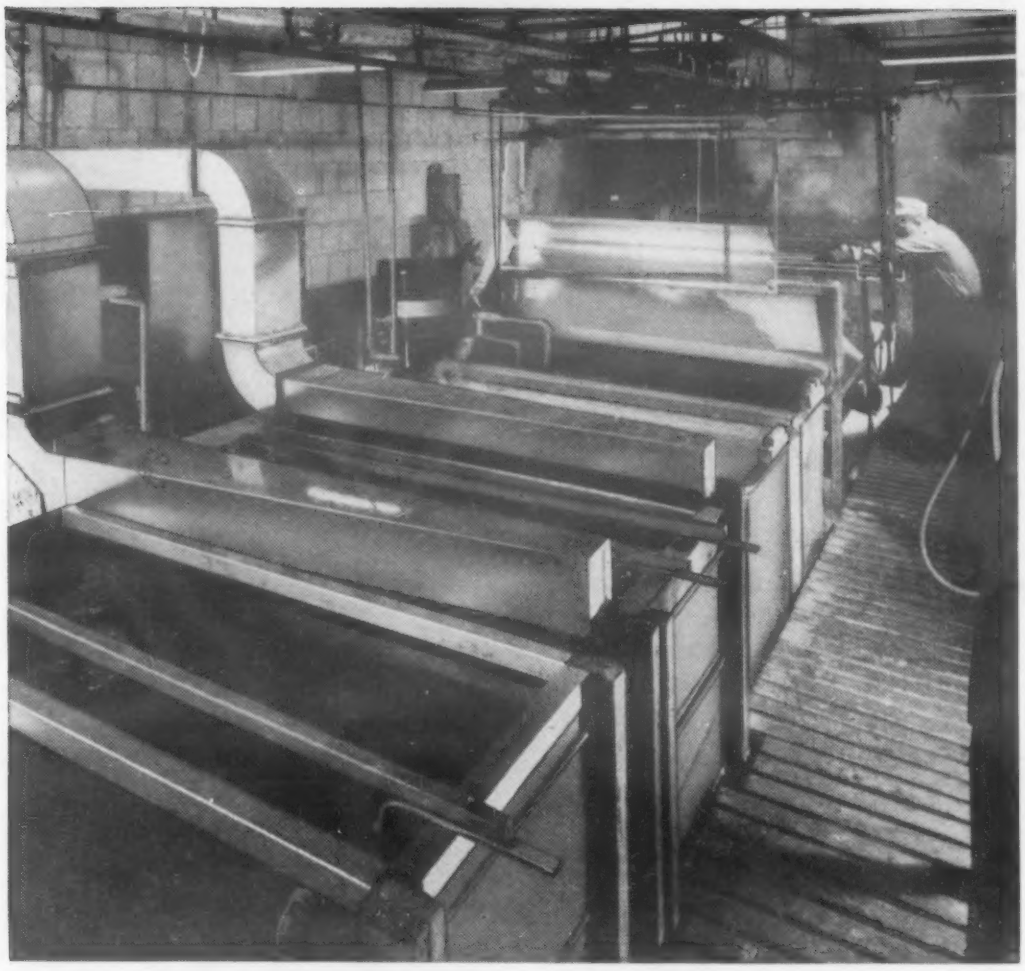
Improvements in high temperature creep rupture characteristics of Type 347 stainless can be achieved through cold work or warm work as follows:

1. At 1200 F, up to 30% cold reduction yields improvements in hot strength for rupture times up to at least 1000 hr.
2. At 1300 F, up to 10% cold reduction improves hot strength for 1000 hr rupture life, and over 30% improves strength for rupture lives up to 1 hr.
3. At 1500 F, up to 20% cold reduction raises allowable stress for a 1 hr rupture life, but cold working is not beneficial for rupture lives greater than about 1 hr.
4. At 1100 F and lower, it seems that significant improvements can be achieved for long-time use, by means of cold work up to 30% or more.

BOOKS

ASTM Standards on Plastics. *American Society for Testing Materials, Philadelphia 3, Pa. 1955. Paper 6 by 9 in. 790 pp. Price $5.75.*

This compilation contains ASTM standards and tentative specifications, methods of analysis and physical testing, and recommended practices and definitions



Choosing Chemicals for Aluminum Treatment Prior to Anodizing

Better production processes and techniques are today's answer to the growing industrial and consumer demand for aluminum products.

In one area, that of anodizing pre-treatment, several general production changes are occuring. For example, many manufacturers seeking a satin finish prior to anodizing have stopped using an alkaline etchant for both cleaning and etching. By forcing it to do double duty, etching solution life was shortened and rejects were high. Selective etching and variations in reflectivity often occurred.

The answer was to divide cleaning and etching into two steps. By using Diversey No. 202 they are assured of both successful removal of oils, greases and marking inks *and* effective keying of the surface for a uniform etch. This cleaning action prolongs the life of the etching solution by freeing it of large amounts of contamination. Then Aluminux, an easily controlled etchant, is used to produce a uniform, diffused satin etch. In addition to being an outstanding etchant, Aluminux cuts costs two ways: 1) It eliminates scale problems by holding greater amounts of sodium aluminate in solution and 2) This greater contamination capacity makes etching solutions effective for longer periods.

To prevent smut build-up and drag-in of alkaline solution to the anodizing bath, Diversey No. 514 is used following etch. No. 514 thus prolongs anodizing solution life. It also assures an even anodic coat by providing a uniform, de-oxidized surface prior to anodizing. A granular acidic product, No. 514 emits no toxic gases, is easier to handle than acids in carboys, is used at room temperatures and is simple to control.

For additional information on No. 202, Aluminux and No. 514 for satin finished aluminum prior to anodic coating, write to The Diversey Corporation, 1820 Roscoe Street, Chicago 13, Illinois.

CONTENTS NOTED

BOOKS

of terms relating to plastics. It contains a total of 143 specifications and tests—four of them new and 41 revised, reaffirmed or advanced from tentative to standard status.

Specifications and Tests for Electrodeposited Metallic Coatings. *American Society for Testing Materials, Philadelphia 3, Pa. 1955. Paper 6 by 9 in. 104 pp. Price $1.85.*

This compilation of 17 specifications, methods of test and recommended practices embodies the work of Committee B-8 on electrodeposited metallic coatings. It contains specifications for zinc, cadmium, nickel-chromium and lead on steel; nickel-chromium on zinc; and chromate finishes on zinc coatings. Also included are recommended practices for: preparation of carbon steel, zinc-base die castings and copper base alloys for electroplating; chromium plating on steels; and preparation of and electroplating on stainless steel and aluminum alloys.

Basic Mathematics for Science and Engineering. *Paul G. Andres, Hugh J. Miser and Haim Reingold. John Wiley & Sons, Inc., New York, N. Y. 1955. Cloth 6 by 9 in. 846 pp. Price $6.75.*

Although prepared as a text for students of science and engineering, this book will serve as a valuable reference for the engineer whose work does not require daily use of mathematics. Topics include algebra, trigonometry, analytic geometry and introductory calculus. The mathematical principles are illustrated with applications chosen from a variety of scientific and engineering fields, with terminology and notations drawn from current technical usage. Each chapter begins with a brief discussion which places the material in a scientific and engineering setting, and concludes with a summary of the subject covered.

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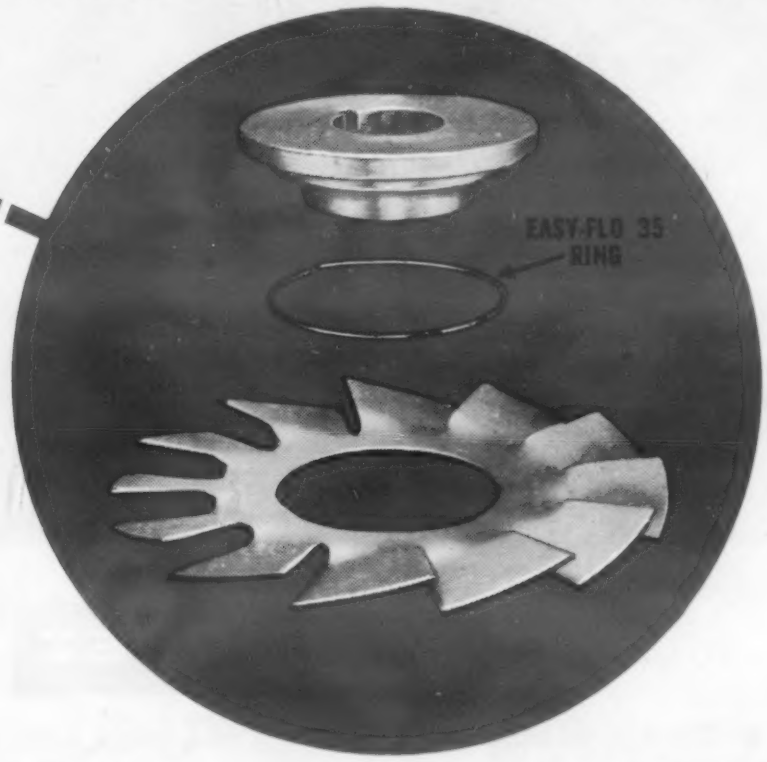

Fans for B&D portable drills are made by brazing steel hubs into stamped steel blades on the city gas-air setup shown. Parts are degreased and assembled, with a ring of EASY-FLO 35 dipped in Handy Flux and preplaced between hub and blade. Mechanism moves assemblies along under burners. An assembly is completed every 6 seconds! One operator does it all!

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CONTENTS NOTED

BOOKS

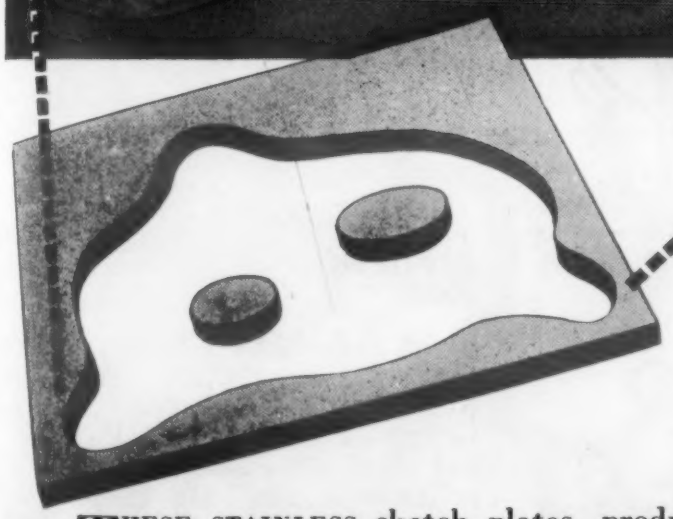
duced in the first chapter which contains also a discussion of the slide rule and its operation. The remaining 19 chapters cover such topics as algebraic operations, trigonometric functions, properties of vectors, logarithms, the Doolittle method of solving simultaneous linear equations, elements of solid analytic geometry, differential calculus and integral calculus. Graphical methods are stressed throughout. Explanations are complete and are accompanied by many worked-out examples. Many exercises are included. The book contains a review of the fundamentals of geometry as an appendix.

ASTM Specifications for Steel Piping Materials. *American Society for Testing Materials, 1955. Cloth 6 by 9 in. 432 pp. Price $4.00.*

This compilation contains the latest approved form of 58 specifications for ferrous pipes, tubes, castings, fittings and bolting materials. The book includes three new and 47 revised specifications. New specifications are given for metal arc welded steel pipe for high pressure transmission service, cold drawn wrought iron heat exchanger and condenser tubes, and alloy steel castings normalized and drawn for high pressure and elevated temperature service.

Elevated Temperature Properties of Carbon Steels. *American Society for Testing Materials, 1955. Paper 9 by 12 in. 68 pp. Price $3.75.*

This is the fourth publication in the current series sponsored by the ASTM-ASME Joint Committee on the Effect of Temperature on the Elevated Temperature Properties of Metals. This compilation on carbon steel includes data on tensile and yield strength, elongation and reduction of area, stresses for creep rates of 0.0001 and 0.00001% per hr and rupture strengths for 100, 1000, 10,000 and 100,000 hr. Properties are



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CONTENTS NOTED

BOOKS

given in graphical form supplemented by copies of original data sheets.

Modern Physics: A Textbook for Engineers. *Robert L. Sproull. John Wiley & Sons, Inc., New York 16, N. Y. 1956. Cloth 6 by 9 in. 491 pp. Price $7.75.*

This book aims to present to engineers the most important twentieth century developments in physics. It describes the modern physics of electrons, atoms and nuclei and applies this basic physics to problems of engineering interest. Included are chapters on fundamental particles; assemblies of particles; atoms and nuclei; wave-particle experiments; quantum mechanics; atomic structure; electrical, thermal and mechanical properties of solids; semiconductors; physical electronics; and applied nuclear physics.

The book is analytical in approach. Organized for self-study or for formal program, it contains numerous problems and offers selected references for further study at the end of each chapter.

REPORTS

Rivet strength STATIC SHEAR STRENGTH OF 2117-T4 (A17S-T4) ALUMINUM-ALLOY RIVETS AT ELEVATED TEMPERATURES. *W. J. Denwalt and K. O. Bogardus, Aluminum Co. of America. Jan 1956. 12 pp., diagrams, photos, tables. Available from National Advisory Committee for Aeronautics, 1512 "H" St., N.W., Wash. 25, D. C. (RM 55130)*

Tests were made of 3/16-in.-dia rivets at temperatures up to 800 F. Time at temperature prior to testing ranged from ½ to 720 hr.

Strength of aluminum INVESTIGATION OF THE COMPRESSIVE STRENGTH AND CREEP LIFETIME OF 2024-T3 ALUMINUM-ALLOY PLATES AT ELEVATED TEMPERATURES. *Eldon E. Mathauser and William D. Deveikis. Jan 1956. 40 pp., diagrams, photos, tables. Available from National Advisory Committee for Aeronautics, 1512 "H" St., N.W., Wash. 25, D. C. (Supersedes RM L55E11b)*

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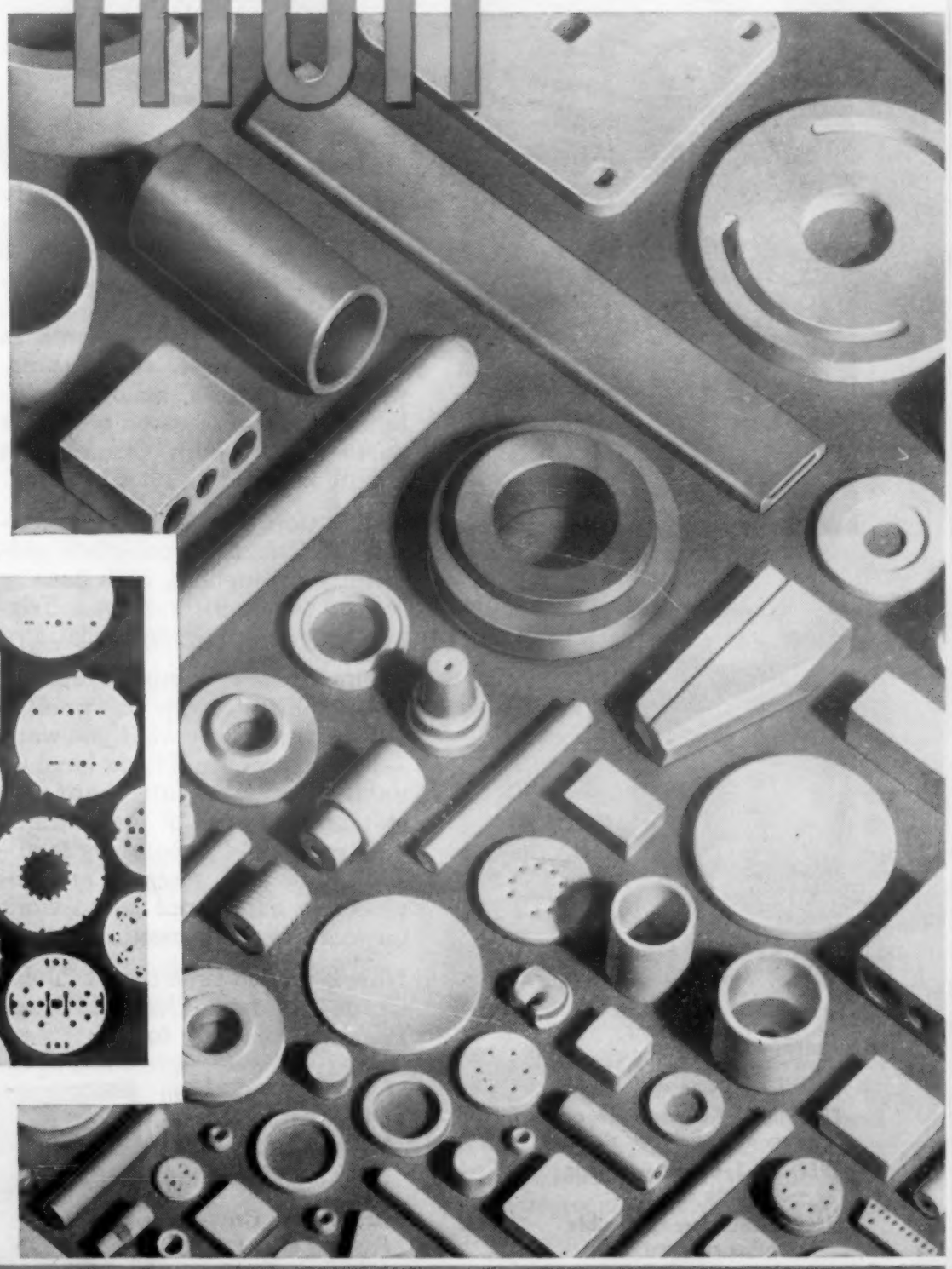

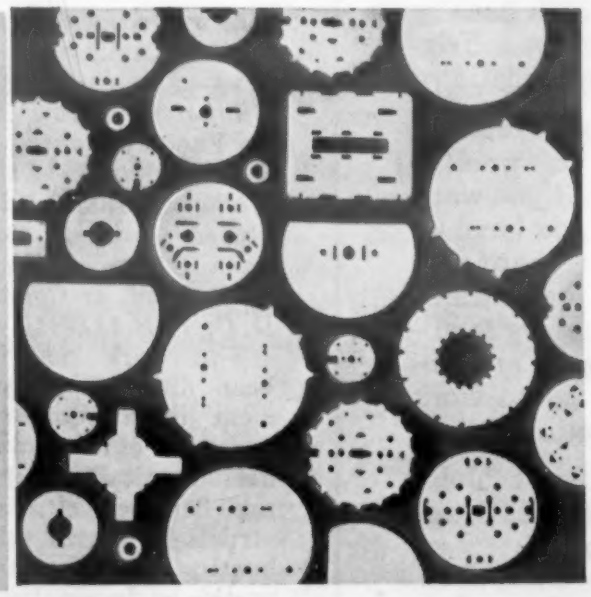

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CONTENTS NOTED

REPORTS

master creep-lifetime curves, using a time-temperature parameter that is convenient for summarizing tensile creep-rupture data. Use of time-dependent stress-strain curves obtained from plate-creep curves for predicting plate-creep failure stresses is investigated.

Polyester laminates CURING OF VOID-FREE GLASS-CLOTH-REINFORCED LAMINATES AT ROOM TEMPERATURE. *Bruce G. Heebink. U.S. Forest Products Laboratory, Madison, Wis. Mar 1955. 35 pp., photos, graphs, tables. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D. C. (PB 111823)*

Coating for steel QUALITY TESTS FOR BLACK OXIDE COATINGS ON STEEL. *Jodie Doss. U.S. Arsenal, Rock Island, Ill. Apr 1955. 11 pp., photos. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D. C. 50 cents. (PB 111725)*

Thirteen types of steel were black oxide-treated in an aqueous alkaline oxidizing bath for various periods of time. Four different test methods were investigated in order to develop a test that would indicate the quality of black oxide coatings. It is recommended that a new oxalic acid spot test replace the ½-hr, salt fog test.

Adhesive bonding DEVELOPMENT OF ROOM-TEMPERATURE-CURING STRUCTURAL ADHESIVES FOR METALS. *Johan Bjorksten, Risto P. Lappala, Luther L. Yaeger, Robert J. Roth. Bjorksten Research Laboratories, Inc., Madison, Wis. Jul 1954. 89 pp., photos, graphs, tables. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D. C. (PB 111764)*

The work described herein has been directed toward the development of a room-temperature low-pressure curing metal-to-metal adhesive suitable for the fabrication and field repair of certain airframe structural parts where the use of heating and pressurizing equipment would be impractical or impossible. An adhesive designated as P-262A, consisting basically of methacrylic acid and methyl methacrylate, has been developed which meets most of the research objectives and possesses properties comparable to those required by MIL-A 8331.

Materials for nitric acid. MATERIALS FOR HANDLING FUMING NITRIC ACID AND PROPERTIES OF FUMING NITRIC ACID WITH REFERENCE TO ITS THERMAL STABILITY. *M. G. Fontana. Ohio State University Research Foundation, Columbus, Ohio. May*

CONTENTS NOTED

REPORTS

1955. 83 pp., photos, drawings, diagrams, graphs, tables. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D.C. $2.25 (PB 111877)

Corrosion fatigue studies were made on RC-70 titanium, titanium alloy Ti-150-A, Armco 17-7PH stainless steel, and 1100 aluminum in WFNA (1.5% NO_2) and RFNA (10.5% NO_2) at room temperature. These experiments were made using platinum as the inert anode and current densities ranging from 1.5 to 10 ma per sq in., depending on test conditions.

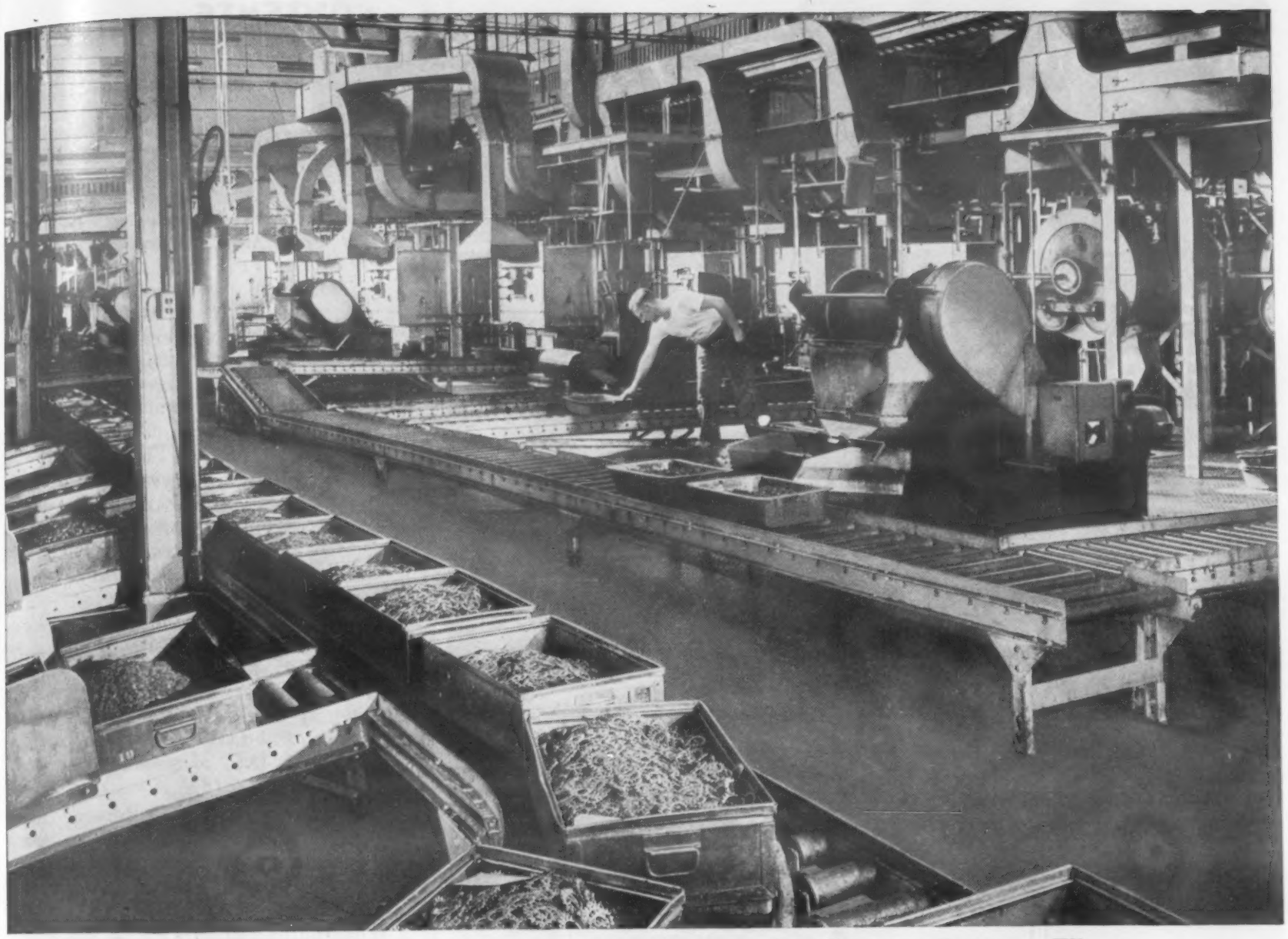
Boron polymers RESEARCH ON BORON POLYMERS. PART 11: POLYMER STUDIES. *William L. Ruigh, Charles E. Erickson, Frank Gunderloy, Michael Sedlak. Rutgers University. School of Chemistry, New Brunswick, N.J. May 1955 85 pp., graphs, tables. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. (PB 111892)*

An exploratory study has been made of certain boron compounds and polymers in connection with the development of plastics and elasomers which are thermally stable, as well as oil- and fuel-resistant.

High temperature alloys DEVELOPMENT OF WROUGHT AND CAST ALLOYS FOR HIGH TEMPERATURE APPLICATIONS. *R. R. MacFarlane, R. S. De Fries, E. E. Reynolds, W. W. Dyrakacz. Allegheny Ludlum Steel Corp., Watervliet Research Laboratory, Apr 1955. 93 pp., photos, graphs, tables. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. (PB 111891)*

Developmental studies were conducted on wrought iron-base and both wrought and cast cobalt-base alloys for applications at high temperatures. A heat treatable, iron-base, austenitic alloy containing manganese and chromium was modified with boron to give excellent stress-rupture properties at 1200 F. A wrought cobalt-base alloy with good stress-rupture properties at 1600 and 1700 F and improved oxidation resistance was developed. Composition levels giving optimum properties were determined for the cast cobalt-base alloys. Modifications involving boron were investigated in both wrought and cast cobalt-base alloys.

Titanium TENSILE PROPERTIES AND RHEOTROPIC BEHAVIOR OF TITANIUM ALLOYS AND MOLYBDENUM. *E. J. Ripling. Case Institute of Technology, Cleveland, Ohio. May 1955. 135*



At low heat-hour cost . . . Nichrome muffles give thousands of hours of high temperature service in gas furnaces manufactured by the American Gas Furnaces Company, Elizabeth, N. J., in operation at plant of Shakeproof Div., Illinois Tool Works, Elgin, Ill.

Nichrome muffle . . . able to handle corrosive gas for 5½ years at 1600°F

HANDLING A CORROSIVE MIXTURE of city gas and ammonia, a Nichrome muffle used for heat treating small steel parts completed 36,732 hours of almost uninterrupted service at 1600°F.

But this temperature is no severe test for Nichrome. Even at higher temperatures, under normal heating conditions you'll find little deterioration of this 60% nickel-15% chromium-iron alloy.

Actually, the big story about a Nichrome muffle is its ability to withstand "thermal shock." Shock from repeated alternate heating and cooling. And shock from intermittent charging of cold work.

Naturally, the 60% nickel content in Nichrome produces significant effects. For one thing, it improves load-carrying characteristics at elevated temperatures. Equally important, the nickel addition plays a major role in improving resistance to scaling from common industrial atmospheres.

A typical Nichrome* muffle, produced by Driver-Harris Co., Harrison, N. J. Nichrome muffles of this type weigh from 291 to 2775 lbs., depending on furnace size and function.

*Reg. Trademark of Driver-Harris Co.

That's why you find Nichrome muffles, retorts and other heat treating components used extensively for nitriding, for carburizing, for oxidation . . . for handling reducing gases, and for operations involving high temperature fatigue.

If you have a metal problem, we'll be glad to help with our wide practical experience. No matter what your industry, send the details of your difficulty for our suggestions. Write us now.

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

For more information, turn to Reader Service Card, Circle No. 335

CONTENTS NOTED

REPORTS

pp., photos, graphs, tables. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. $3.50. (PB 111898)

Unnotched and notched tensile properties are described as a function of testing temperature for a series of titanium-nitrogen and titanium-manganese binary alloys, as well as for the commercial alloy, Ti 140A, and the experimental 3 Mn-complex alloy. (TR 55-5).

Testing rubber INVESTIGATION OF TECHNIQUES AND APPARATUS FOR DYNAMIC TESTING OF RUBBER. *Final report under Contract DA-11-022 ord-1628 for the period Jul 8, 1954 to May 31, 1955. J. S. Islinger, V. F. Petrie, W. T. Savage. Armour Research Foundation, Chicago, Ill. Jul 1955. 49 pp., photos, diagrams, graphs, tables. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mimeo $3.30, photo $7.30. (PB 118816)*

High temperature rubbers RESEARCH ON THE PREPARATION AND PROPERTIES OF HIGH-TEMPERATURE RESISTANT COPOLYMERS. *Gerald A. Edwards. Tuskegee Institute. George Washington Carver Foundation. May 1954. 23 pp., tables. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. 75 cents. (PB 111765)*

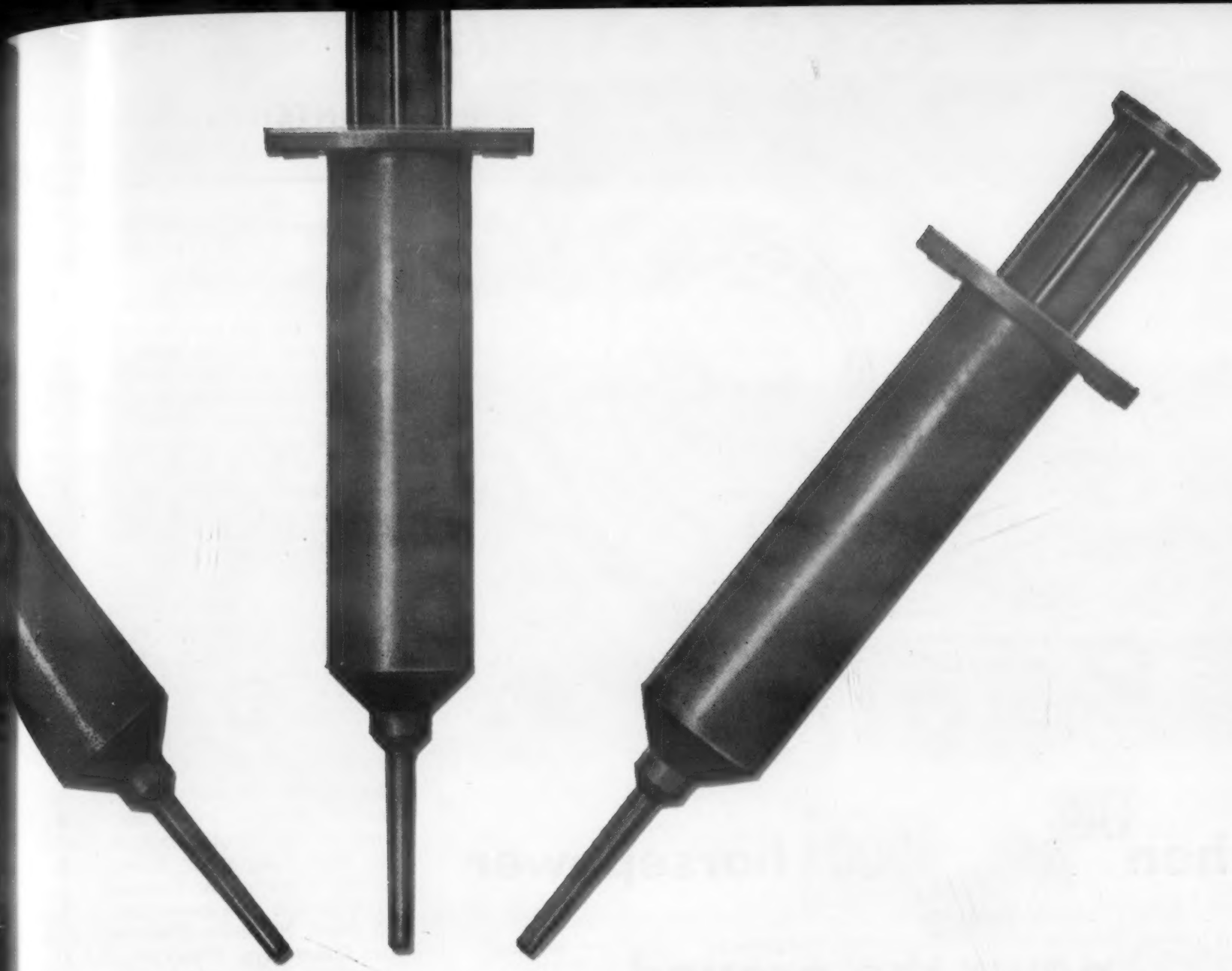
The reaction between para-dichlorobenzene and alkali metals in the presence of various unsaturated compounds has been investigated for the purpose of determining whether heat resistant copolymers could thus be prepared.

Stressed materials FAILURE OF MATERIALS UNDER COMBINED REPEATED STRESSES WITH SUPERIMPOSED STATIC STRESSES. *George Sines. U. S. National Advisory Committee for Aeronautics. Nov 1955. 69 pp., photos, drawings, diagrams, graphs, tables. Available from National Advisory Committee for Aeronautics, 1515 "H" Street, N.W., Wash. 25, D. C. (PB 118890)*

Coated nylon fabrics SHELF LIFE OF NEOPRENE COATED NYLON FABRICS. *R. Briganti. U. S. Naval Supply Activities. Clothing Supply Office, Brooklyn, N.Y. Apr 1955. 20 pp., tables. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D.C. 75 cents. (PB 111728)*

(Reports continued on p. 210)

Don't forget the
DESIGN ENGINEERING SHOW
Philadelphia Convention Hall
May 14-17.



Syringes made of **TENITE POLYETHYLENE** are non-reactive, non-toxic and inexpensive enough to throw away after one use

These veterinary syringes made of Tenite Polyethylene are a new idea. They are both container and dispenser for drugs.

Pharmaceutical firms load them with the right dosage of a specific drug and sell them as single-treatment packages.

Veterinarians or farmers buy these pre-loaded syringes, administer the drugs to the animals and then throw the syringes away. There's no re-use of the syringe, there's no chance to infect other animals. Since Tenite Polyethylene is reported chemically inert to these sensitive drugs this means complete protection with no danger of contamination or chemical reaction.

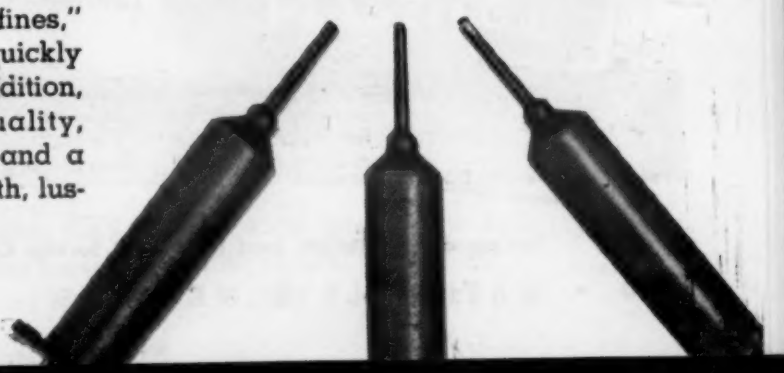
Ideas like this are expanding the use of versatile Polyethylene. Today, applications include packaging film, molded products, wire and cable insulation, pipe and tubing, paper coatings and unbreakable containers of all types.

Does Tenite Polyethylene give you ideas? Perhaps you have a product that could be given more sales appeal, better performance or longer life if made of Polyethylene. If so, make it of *Tenite* Polyethylene.

There are many advantages to specifying Tenite Polyethylene. This Eastman plastic comes in the form of spherical pellets that flow freely through molding and extrusion machine hoppers. Their smooth surfaces resist dirt and, because there are fewer "fines," molders can clean hoppers quickly when changing colors. In addition, you get outstanding color quality, homogeneous color dispersion and a finish that approaches the smooth, lustrous surfaces obtained with plastics of much greater inherent hardness.

For advice and more information, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE
POLYETHYLENE
an Eastman plastic



For more information, turn to Reader Service Card, Circle No. 329

CONTENTS NOTED

REPORTS

Properties of acrylics ELEVATED- AND ROOM-TEMPERATURE PROPERTIES OF TRANSPARENT ACRYLIC SHEET MATERIALS. *John Van Echo, Gale R. Remely and Ward F. Simmons, Battelle Memorial Institute, Columbus, Ohio. Feb. 1952. 40 pp., photos, diagrams, graphs, tables. Available from Library of Congress, Photoduplication Service Publication Board Project, Wash. D.C. Mi $3, ph $6.30. (PB 118802)*

Two regular grades of transparent acrylic sheet, Plexiglas Ia and Lucite HC-201, and two heat-resistant grades, Lucite HC-202 and Plexiglas H, were tested in tensile creep and creep rupture, crazing, short-time tensile, and deterioration at room temperature 160 and 200 F.

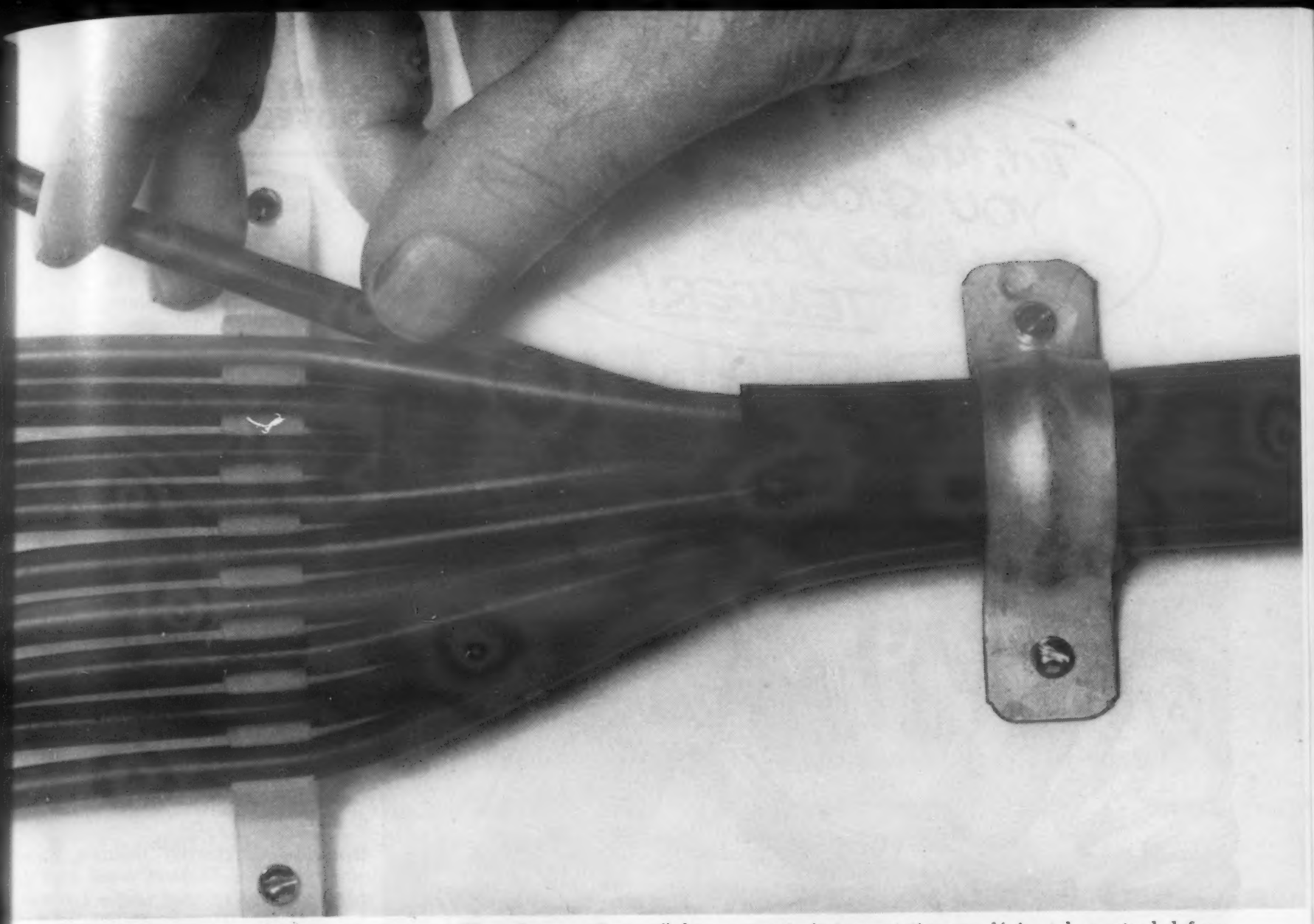
Dielectric materials MEASUREMENTS OF THE DIELECTRIC PROPERTIES OF SOLID POLYMERIC MATERIALS IN THE FREQUENCY RANGE 35,000-40,000 MEGACYCLES. *Technical report 31B. Donald A. Yamada and Richard N. Work. Princeton University. Plastics Laboratory, Princeton, N.J. Dec. 1953. 35 pp., diagram, table. Available from Library of Congress, Publications Board Project, Wash. 25, D.C. Mi $3, ph $6.30. (PB 118680)*

A method of measuring the complex dielectric constant of low-loss and medium-loss solid dielectric materials at 35,000 mc/s to 39,700 mc/s is described. A table of measured values of ϵ' and ϵ'' is included for ten high polymeric insulating materials and for two glass bonded mica materials.

Strippable coatings DEVELOPMENT OF COLD DIP STRIPPABLE COMPOUNDS. THIRD REPORT. *M. H. Sandler, U. S. Aberdeen Proving Ground. Development and Proof Services, Aberdeen, Md. Apr. 1952. 23 pp., tables. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $2.70, ph $4.80. (PB 118321)*

STRIPPABLE COATING, APPLICATION AND MAINTENANCE. REVISED. *U.S. Bureau of Ordinance. Dec. 1954. 53 pp., photos, drawings, diagrams, tables. Order from Superintendent of Documents, Government Printing Office, Wash. 25, D.C. 55 cents. (PB 85255r)*

Transparent coatings ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION STUDY OF OPTICALLY TRANSPARENT ELECTRICALLY CONDUCTING COATINGS ON GLASS AND ACRYLIC PLASTIC. *Stanley A. Szaqlewicz. U.S. Air Force. Air Research and Develop-*



These low-cost "nerves" for pneumatic instrumentation are ¼-in. tubes extruded from BAKELITE Brand Polyethylene. They saved one chemical plant over ¾ million dollars in installation costs by averaging only 14½ cents per foot compared with $2.10 for rigid metal tubes. They are bundled together in harness extruded of BAKELITE Brand Vinyl Plastic or carried separately in racks molded of polyethylene as shown. "Dekoron" tubes are manufactured by **Samuel Moore & Co.,** Mantua, Ohio.

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with BAKELITE extrusion materials

Polyethylene is one of several BAKELITE plastics extrusion materials available to help you find the best combination of properties for your production.

For the pneumatic tubing illustrated, polyethylene's flexibility made it possible to bend tubing easily around corners, thread through hard-to-reach places. Its light weight permitted simple mountings without elaborate supports. Its colors helped in coding, and its chemical resistance provided long service life.

The variety of BAKELITE Brand extrusion materials provides a broad range of properties for a multiplicity of jobs. *Polyethylene* can be compounded for excellent resistance to weathering. It's outstanding for insulation and jacketing on wire and cable. *Vinyls* provide a range of opaque and transparent colors combined with toughness—important to such products as belting, welting, and garden hose. *Styrene* monofilaments are used for tough, soap-and-water-resistant brush bristles. *Impact styrenes* can be extruded into sheets for vacuum-forming of refrigerator door liners and other large sections.

Learn how plastics extrusions can effect production short-cuts that represent important savings in costs. Write Dept. NW-108 today for further information. Be certain to provide sufficient details for thorough evaluation of your problem.

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In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

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For more information, turn to Reader Service Card, Circle No. 516

CONTENTS NOTED

REPORTS

ment Command. Wright Air Development Center. Materials Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio. Mar. 1953. 27 pp., photos, tables. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $2.70, ph $4.80. (PB 118266)

Commercial conductive coatings on glass were investigated by electron microscopy and electron diffraction. Coatings consisted primarily of very small stannic oxide crystals which were uniformly dispersed in a thin film and were firmly bonded to the glass surface. Experimental conductive coatings of stannic oxide which were formed on glass at relatively low temperatures had poor adhesions to the substrates. A graphite coating in which the conductivity was produced largely by the rubbing process showed a strong orientation of the planes.

Borides CEMENTED BORIDES. *Summary progress report from June 1, 1952 to May 1, 1953 under Contract N6 onr-256. Frank W. Glaser and others. American Electro Metal Corp., Yonkers, N.Y. May 1953. 188 pp., photos, diagrams, graphs, tables. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $8.40, enl pr $30.30. (PB 118675)*

Titanium CONSTITUTION OF TITANIUM ALLOY SYSTEMS. SUPPLEMENT 1. *David W. Levinson, Donald J. McPherson, and William Rostoker. Armour Research Foundation, Chicago, Ill. Sept. 1954. 155 pp., diagrams, graphs. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. $4. (PB 111508s)*

New information available in the period Feb. 1953 to Sept. 1954 relating to binary and ternary systems, including crystal structures, is compiled and critically evaluated.

Metal deformation DEFORMATION STUDIES OF METALS AT ELEVATED TEMPERATURES. *II. Iron-chromium-nickel tenary system. III. Effect of structure and composition on the strength properties of stainless steel. Periodic status report no. 9, for the period Sept. 1954-Nov. 1954 under Contract N5 ori-07881, NR 039-007. N. J. Grant, H. C. Chang, F. C. Monkman, and P. E. Price. Massachusetts Institute of Technology. Dept. of Metallurgy. Nov. 1954. 4 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $1.80, ph $1.80. (PB 118662)*

(More Reports on p. 214)

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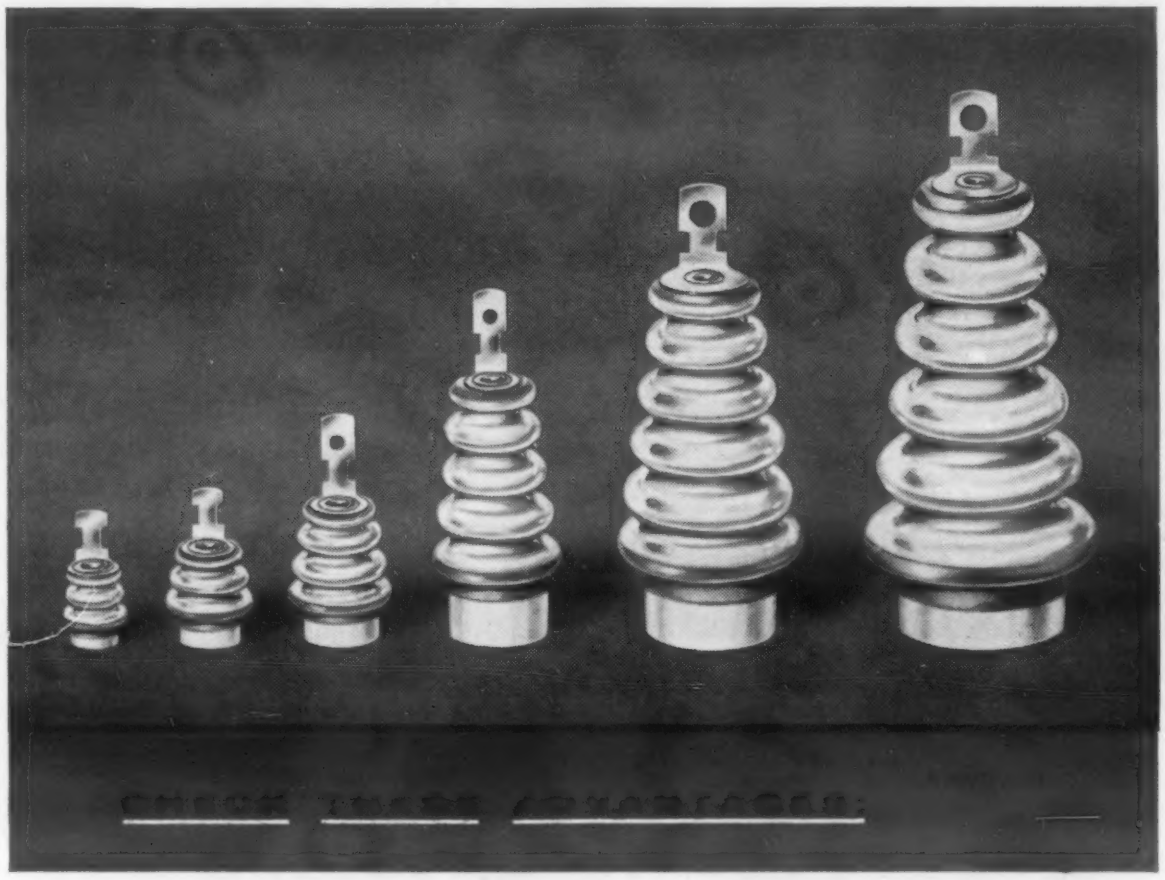
Frenchtown NICOTE Metallized Terminals!

● After years of extensive research into hermetic seal problems in the electronics and electrical fields, Frenchtown proudly presents this *improved line* of Annuluted Type NICOTE Metallized Hermetic Terminals for use in controls, relays, transformers, capacitors, motors and heater units.

Custom-engineered of HIGH ALUMINA CERAMICS and metallized with Frenchtown's exclusive NICOTE. These terminals are available in six varying sizes with a choice of terminal hardware to fit any exacting application.



- **Will withstand *continuous* immersion in lead-tin solder at 260°C. (500°F.).**
- **Reduce tracking through superior external shape, so important in smaller size terminals.**
- **Provide easier threading of wire through terminal because of improved *tapered* bore design.**
- **Effect a permanent, positive seal that is resistant to high thermal and mechanical shock.**

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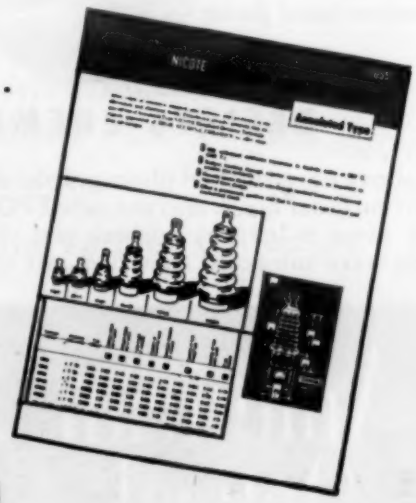
We'll be pleased to show you the complete line of Frenchtown NICOTE Metallized Hermetic Terminals at our Booth No. 26, I.R.E. Show, Kingsbridge Palace, March 19-22, 1956.

FOR COMPLETE INFORMATION . . .

. . . send for Engineering Data Sheet 1055 which provides specifications for the complete line of Frenchtown NICOTE Metallized Hermetic Terminals . . . plus engineering details on a wide selection of terminal hardware.



frenchtown PORCELAIN COMPANY

84 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

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CONTENTS NOTED

REPORTS

Alloys for turbines DEVELOPMENT OF FORGING AND CASTING ALLOYS FOR TURBINE BUCKETS. *Ralph P. De Vries, Jr. and Gunther Mohling. Allegheny Ludlum Steel Corp, Pittsburgh, Pa. Aug. 1951. 59 pp., photos, graph, tables. Available from Library of Congress, Photoduplication Service, Publicatons Board Project, Wash. 25, D.C. Mi $3.60, ph $9.30. (PB 118760)*

Plating titanium ELECTOPLATING ON TITANIUM. *Final report for period Sept. 1, 1952-Sept. 30, 1953, under Contract DA-11-022-ORD-1045. Harold L. Shick. Armour Research Foundation, Chicago, Ill. Oct. 1953. 12 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $2.40, ph $3.30. (PB 118294).*

Work during the present study utilized fused salt baths, other pickling media, surface pretreatments, and plating techniques used for other active metals.

Creep FUNDAMENTAL STUDIES RELATED TO THE ORIGIN AND CREEP OF METALS. *Thirteenth technical report. Effects of impurities and imperfections on mechanical properties of metals. Earl R. Parker and Jack Washburn. California University, Institute of Engineering Research. Minerals Research Laboratory, Berkeley, Calif. Nov. 1954. 31 pp., diagrams, graphs. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $3, ph $6.30. (PB 118571)*

Cermet oxidation MECHANISM OF CERMET OXIDATION AT HIGH TEMPERATURE. *W. B. Crandall, H. S. Levine, G. E. Lorey, and V. D. Frechette. Alfred University, Alfred, N.Y. Oct. 1950. 12 pp., drawing, graphs. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $2.50, ph $3.30. (PB 118678)*

Boron hydrides STUDIES ON BORON HYDRIDES. *Eighth annual technical report of investigations on water-reactive chemical compounds, for the period Nov. 1, 1953 through Oct. 14, 1954, under Contract N6 onr-238, T.O. 1. Anton B. Burg, Carl D. Good, Peter J. Slota, Jr., Gordon L. Juvinall, Francis M. Graber and James L. Boone. University of Southern California. Dept. of Chemistry, Los Angeles, Calif. No. 1954. 31 pp., tables. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D.C. Mi $3, ph $6.30. (PB 118544)*

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- Coats one or both sides of work.
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NEWS OF | ENGINEERS COMPANIES SOCIETIES

NEWS OF ENGINEERS

Chester E. Davis, executive vice president, Alan Wood Steel Co., has been elected a member of the company's board of directors.

James W. Deaderick has been promoted to the position of technical director of research, American Lava Corp.

Guy H. Pitts has been named manager, Fabrication Div., Bohn Aluminum & Brass Corp.

Robert G. Hess has been appointed executive vice president, Pesco Products Div., Borg-Warner Corp.

William R. Toeplitz has been advanced to the post of president, Bound Brook Oil-Less Bearing Co.

Walter G. Cox has recently joined the Brunswick-Balke-Collender Co.'s Reinforced Plastic Div. as a design engineer in the project group.

A. K. Doolittle has been made senior scientist in the Research Dept., Carbide and Carbon Chemicals Co.

Boyd Johnson, general manager of the Refractories Div., The Carborundum Co., has been elected vice president of the company.

Paul C. Ackerman has been given the newly-created position of director of engineering, Chrysler Corp. In addition, Mr. Ackerman assumes chairmanship of the company's newly-formed Engineering Executive Committee.

Felix E. Wormser, assistant secretary of the Interior, has been named 1956 recipient of Columbia University's Egleston Medal.

Dr. James K. Stanley has been made supervisor of Crucible Steel Co. of America's Silicon Steels and Magnetic Materials Research Section.

H. K. Intemann has been appointed executive vice-president, Electro Metallurgical Co.

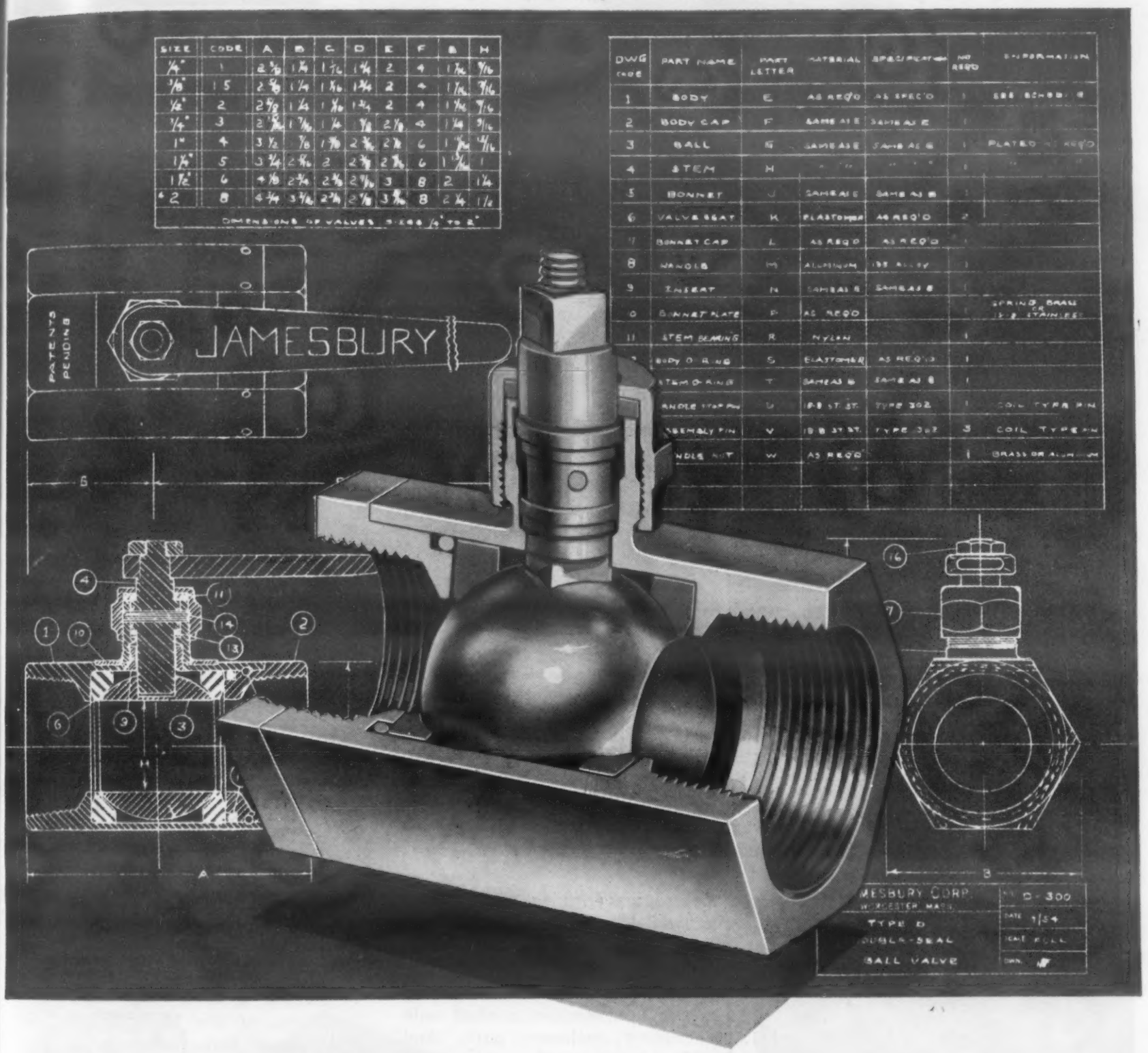
John Gabrenas has become associated with Firth-Loach Metals, Inc., as chief engineer.

Robert L. Collins has been named manufacturing manager, Special Products Div., Ford Motor Co.

William W. Dickhardt III has been made chief of the Machine Design and Development Section, The Franklin Institute Laboratories.

Alfred F. Bauer has been appointed assistant general manager Doehler-

New, all-stainless double-seal ball valve. Its manufacturer, JAMESBURY CORPORATION, Worcester, Mass., stresses its straight-line flow and elimination of practically all maintenance.



STAINLESS means corrosion-resistance in new double-seal ball valve...

The *all-stainless* construction of this new-type, double-seal ball valve means exceptional resistance to corrosion, erosion and abrasion. That's part of the reason why these Jamesbury valves are being used for chemical applications... processing of hot caustic solutions... even for the vacuum fields.

The valve differs from conventional globe or gate valves in that its operation depends upon a stainless steel ball, sealed with a plastic or rubber ring on both sides. All of the valve, including the ball, is machined from Crucible stainless bar stock, type 303 or 316.

Stainless may be the answer for your product, too. Why not let a Crucible engineer give you the facts concerning its most profitable use? *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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news of ENGINEERS

Jarvis Div., National Lead Co. Mr. Bauer will continue to function in his former capacity of chief engineer of the Doehler-Jarvis Div.

Dr. Henry H. Hausner has been engaged by Penn-Texas Corp. as general manager of its Nuclear Engineering Div.

Myron B. Diggin has been made vice president and director, Hanson-Van Winkle-Munning Co.

F. H. Mulligan has been elected president, Charles Hardy, Inc.

Per Ulf Gummeson has been appointed vice president and general manager, Hoeganaes Sponge Iron Corp.

Raymond A. Quadt, director of research, Hunter Douglas Aluminum Corp., has been presented the Navy Meritorious Public Service Citation for his "outstanding contribution to the Navy in the field of research on cold forging the heat treatable aluminum alloys."

R. R. Zisette has been elected a director and vice president-general manager, Jessall Plastics Inc.

Robert R. Johnson has been named chief engineer, Minnesota Rubber and Gasket Co.

Edwin J. Merrell has been made chief engineer, Habirshaw Cable and Wire Div., Phelps Dodge Copper Products Corp., to succeed **A. Del Mar,** who becomes consulting engineer for the company.

John D. Berwick, Jr., has been appointed general superintendent in charge of the Manufacturing Div., Seymour Manufacturing Co.

Dr. John D. Leitch has been named vice president-engineering, Electric Controller and Manufacturing Co., Div. of Square D Co.

Merle W. Kremer, in addition to his present duties as general manufacturing manager, has been given the post of assistant general manager, Parts Div., Sylvania Electric Products Inc.

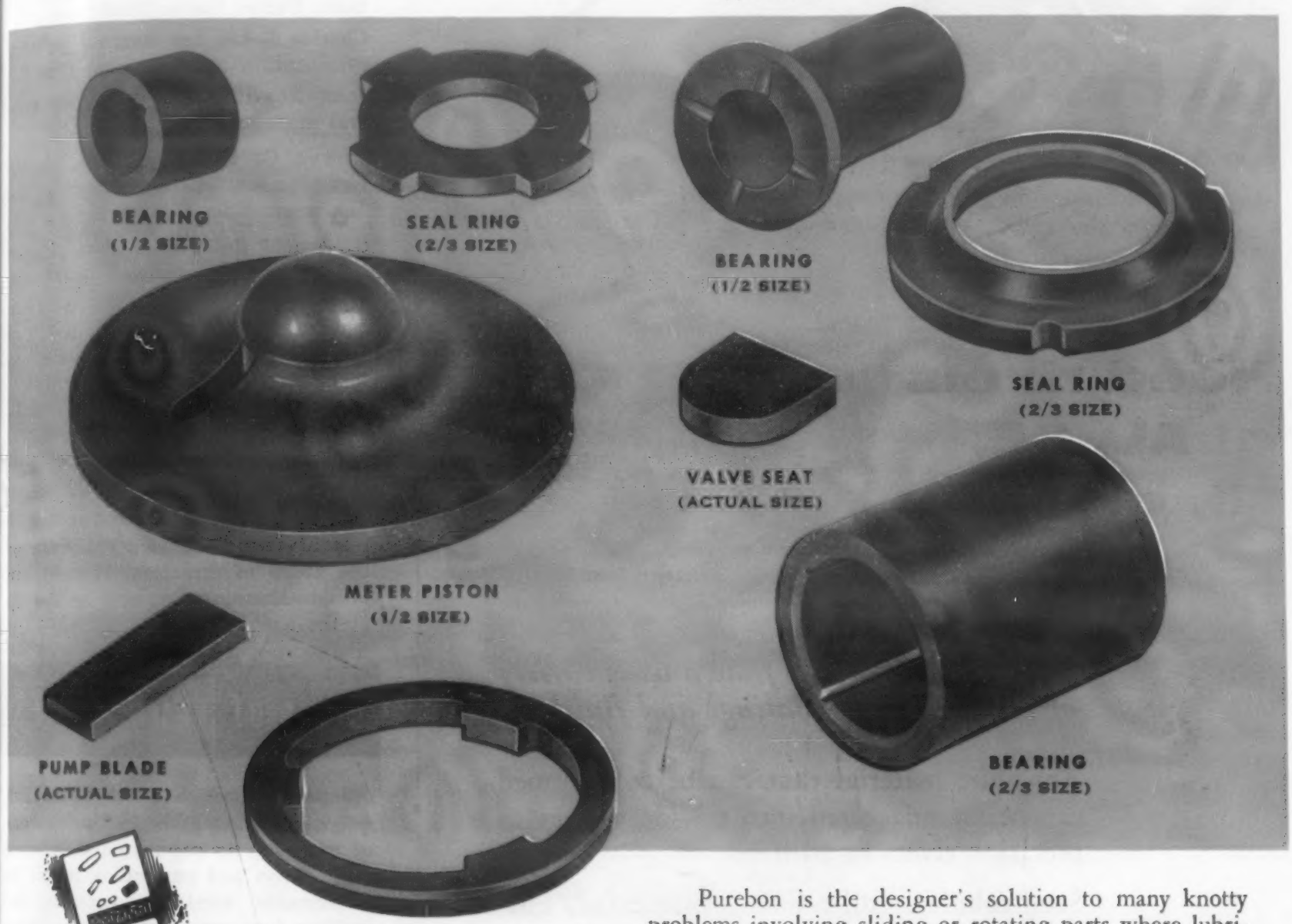
Robert F. Gager has been elected vice president-research, Synco Resins, Inc.

Major General Louis W. Prentiss has been appointed commanding general, Engineer Research and Development Laboratories, U. S. Army Corps of Engineers.

George A. Fowles has accepted an assignment with the U. S. Department of Commerce as director,

. . . the solution to your Lubrication problem is here . . . PUREBON

Carbon-graphite especially designed for mechanical applications.



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COMPRESSOR BLADE
(2/3 SIZE)

PURE CARBON CO., INC.
450 HALL AVENUE
ST. MARYS, PENNSYLVANIA

Purebon is the designer's solution to many knotty problems involving sliding or rotating parts where lubrication is difficult and sometimes impossible. Purebon parts are molded or machined exactly to our customers' specifications here in our own plant, under our close supervision and inspection. *Because of the diversified characteristics of Purebon, applications are limited only by the designer's imagination.* If you have a problem involving insufficient lubrication at critical points of friction, our design engineering department will be happy to work with you toward its swift and successful solution.

PUREBON'S PROPERTIES

1 ***MOLDED TO SIZE—FOR MANY APPLICATIONS***
Tolerances of approximately 1½% of dimension required for molding most shapes.

2 ***SELF-LUBRICATING—OR BY THE MATERIAL HANDLED***
Varies with grade of Purebon.

3 ***STRONG AND TOUGH***
Transverse strength varies from 4,000 to 13,000 lb./sq. in. according to grade.

4 ***READILY MACHINABLE***
Tolerances as close as .0005 can be maintained where required.

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Resistant to attack by chemicals of all kinds, used in food handling and processing equipment.

6 ***HIGH TEMPERATURE APPLICATION***
Most Purebon grades will operate efficiently in temperatures up to 700°F in air or much higher in neutral or reducing atmosphere.

Leaders for over 40 YEARS in PURE CARBON PRODUCTS

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news of ENGINEERS

Chemical and Rubber Div., Business and Defense Services Administration.

C. D. King has been made assistant to executive vice president-operations, United States Steel Corp.

Charles J. Lee has been elected vice president, Wilson Steel and Wire Co.

John Newitt has been named general manager, Kinetics Corp.

George G. Stier has been elected vice president of Nopco Chemical Co. in charge of its Plastics Div.

G. Arnold Roberts has been named supervisor, Engineering Department, Portland Copper and Tank Works.

Dr. S. D. Douglas, senior scientist in the Research Dept., Carbide and Carbon Chemicals Co., died on Jan 15 after a long illness.

H. A. Flannery, manager of engineering for Goodyear Tire & Rubber Co. since 1935, died Jan 28.

Guerin Todd, Sr., vice chairman of the board of directors, Hanson-Van Winkle-Munning Co., died on Jan 23 at the age of 60.

news of COMPANIES

Allegheny Ludlum Steel Corp. has announced that it is in the process of doubling its capacity for refining high alloys and superalloy steels in consumable electrode vacuum remelting furnaces. Two new furnaces are being erected at the Watervliet (New York) plant.

The Beryllium Corp. has acquired the capital stock of **National Precision Casting Corp.**

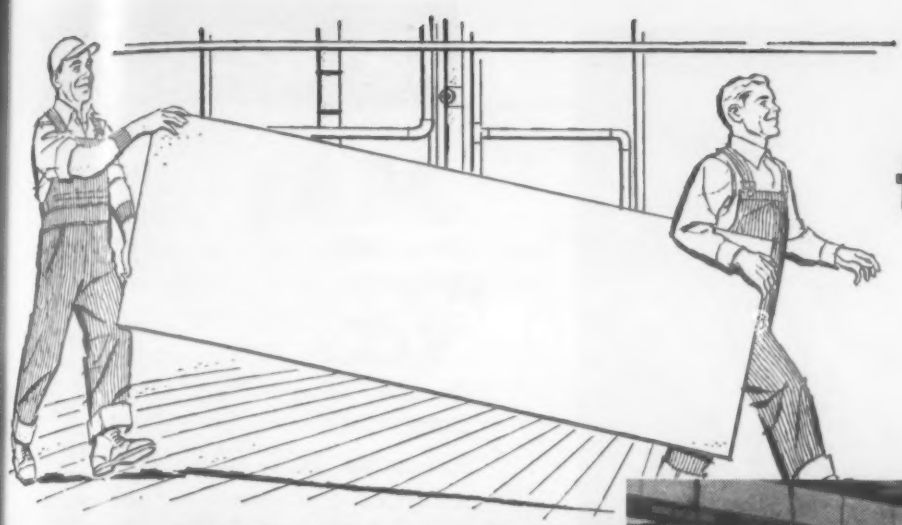
Borg-Warner Corp. has undertaken a major expansion in the plastics manufacturing field by appropriating $10,000,000 for erection of a chemical plant at Washington, W. Va.

Chrysler Corp. has begun construction of a new multi-million dollar automotive stamping plant in Twinsburg, Ohio.

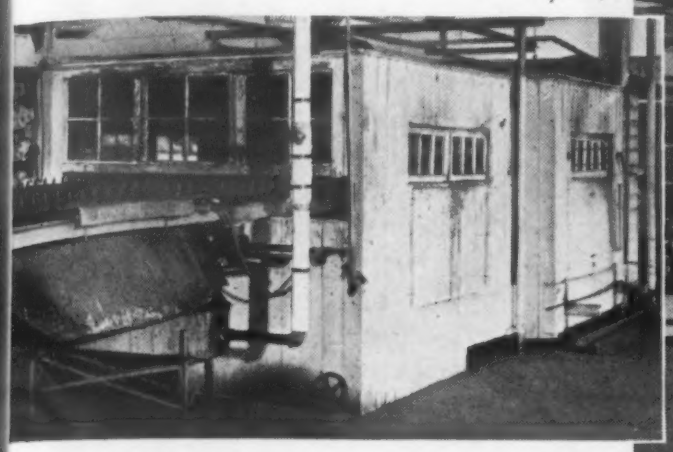
Colt's Manufacturing Co. recently announced that its Plastics Div. has become a wholly-owned subsidiary of **Penn-Texas Corp.** and is now known as Manufactured Products Corp.

Crucible Steel Co. of America has announced plans for installation of a new $2,500,000 mill for cold rolling stainless and titanium strip to thinner gages than previously produced.

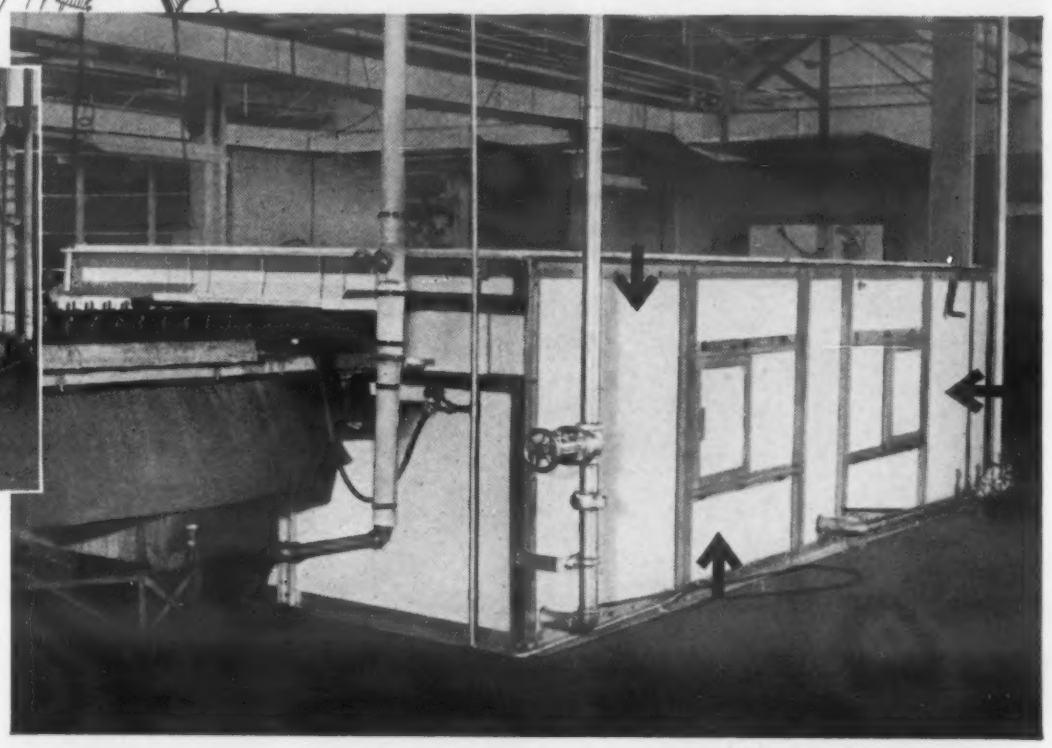
(Continued on p. 222)



NEW tenterframe housing constructed by plant labor



Old tenterframe housing, made of wood was inefficient as well as unattractive. Constant maintenance was required.



New tenterframe housing, made of Marinite panels (indicated by arrows) provides maximum heat control and smart, modern appearance. Easy to keep clean.

At a leading silk mill . . .

J-M MARINITE® builds and insulates in one operation

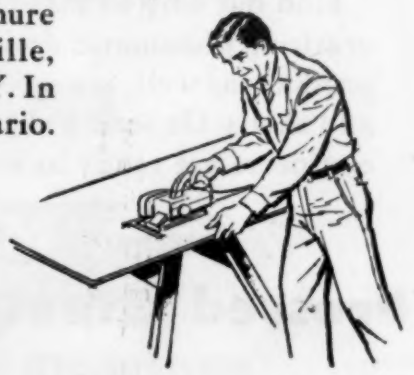
When an old tenterframe housing passed the point of economical efficiency last year, officials of a well-known eastern silk mill turned to J-M Marinite. For they had learned on a previous job that Marinite provides three important advantages over other materials.

1. MARINITE COSTS LESS TO ERECT—the mill's own construction crews could easily perform the work using ordinary woodworking tools. The large easy-to-handle sheets go up fast.

2. MARINITE GIVES BETTER HEAT CONTROL—low heat capacity reduces heat-up and cool-off time. Homogeneous material won't bulge, settle or sag—eliminates "hot spots." Outside framing cuts through-metal heat loss.

3. MARINITE REQUIRES NO MAINTENANCE—inorganic material is unaffected by moisture. Won't rust, rot, mold or corrode. Normally requires no protective coating. Minimizes down-time. Lasts indefinitely.

Made from asbestos and diatomaceous silica, Marinite is the ideal insulating sheet material for tenterframe housings, agers, ovens, driers, and other high temperature equipment. Find out how you can take advantage of its many benefits. Write for new 16-page brochure IN-153A to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.



Easy to work, Marinite may be cut, drilled, and shaped with ordinary woodworking tools.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first-in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

For more information, turn to Reader Service Card, Circle No. 461

news of COMPANIES

The mill will be installed at Crucible's Midland, Pa., works and is scheduled for completion in 1957.

The Dow Chemical Co. has begun construction of a plant for the production of synthetic latex at Pittsburg, Calif.

Escambia Bay Chemical Corp. has awarded a contract for the construction of a polyvinyl chloride resin plant near Pensacola, Fla., which will have a capacity of 30,000,000 lb per yr for use in the manufacture of plastics.

Ford Motor Co. has negotiated plans for construction of a new aluminum foundry to be located at Listerhill, Ala.

The Fort Die Casting Corp. has been purchased by a new corporate group and will be operated by the same management as that of two other Michigan casting industries—**Centr-O-Cast and Engineering Corp.** and **Process Machinery Manufacturing Co.**

Granite City Steel Co. has begun construction of a new blast furnace as a major part of an expansion program designed to increase the company's ingot capacity by about 30% by early 1958.

Kaiser Aluminum & Chemical Corp.'s Kaiser Chemicals Div. has undertaken a $3,000,000 expansion program which will substantially increase its capacity to produce its refractory and magnesia products.

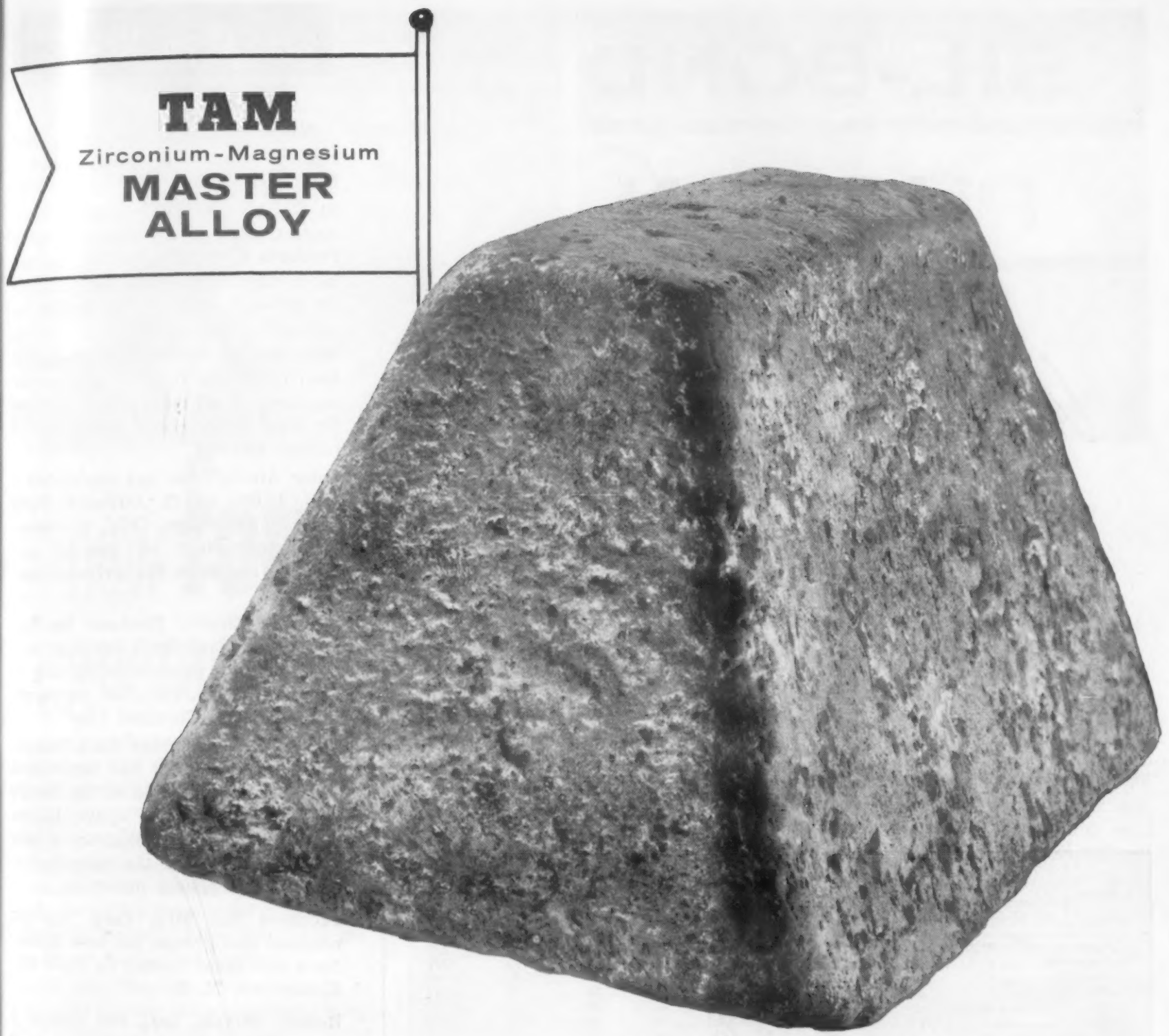
Kennerley-Spratling, Inc., a new plastics molding firm, has announced that production is under way at its new plant at 1456 Fourth St., Berkeley, Calif.

Lewis Welding and Engineering Corp. has split its operations between two autonomous divisions—the Lewis Welding Div., Bedford, Ohio, and the Lewis Machine Div., Euclid, Ohio.

Metal & Thermit Corp. has purchased an 800-acre tract near Montpelier, Va., and will soon begin construction of a plant for mining and processing of titanium-bearing ore.

Midvale-Heppenstall Co. has purchased the assets of **The Midvale Co.** The newly-formed company will be operated as a subsidiary of Heppenstall Co.

Norristown Magnesia and Asbestos Co., Sall Mountain Co., and **Valley Forge Metals Co.** have merged into Nicolet Industries, Inc. Henceforth, they will be known as the following



Easy, Economical Alloying

Readily soluble in production heats of magnesium, TAM's Master Alloy is a most efficient method of alloying zirconium with magnesium. Recoveries of zirconium are high. Fuming in the foundry is minimized and, as a plus feature, the material is easy to store and handle.

The resulting magnesium alloys are known for their retention of high strength at elevated temperatures, fine grained structure, freedom from microporosity and microshrinkage, and minimized contamination. As a result, extruding and casting are improved... useful applications expanded.

TAM Master Alloy has been proved in use by both large and small foundries. Complete detailed information can be obtained through our field engineers and by writing our N. Y. C. office.

TAM
PRODUCTS
Registered U. S. Pat. Off.

TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY

Executive and Sales Offices:
111 Broadway, New York City

General Offices, Works and Research Laboratories:
Niagara Falls, New York

TAM is a registered trademark.

For more information, turn to Reader Service Card, Circle No. 483

news of | COMPANIES

divisions of Nicolet Industries: Norristown Asbestos Div., Sall Mountain Div., and Valley Forge Metals Div.

St. Regis Paper Co. has acquired the capital stock of **Chester Packaging Products Corp.** Chester will operate as a subsidiary of St. Regis under its present organization and management.

Schwarzkopf Development Corp. has been formed to function as a parent company of all enterprises in which Dr. Paul Schwarzkopf has a total or partial interest.

Solar Aircraft Co. has established a new 45,000 sq ft Airframe Parts Plant in San Diego, Calif., to concentrate production on current and pending contracts for airframe components.

Sylvania Electric Products Inc. has announced plans for a new engineering and pilot production building in Towanda, Pa., for the company's Tungsten and Chemical Div.

United States Rubber Co.'s Naugatuck Chemical Div. has acquired a 150-acre tract of land in the Scott's Bluff region of Baton Rouge, La., on which it plans to construct a new chemical plant for the manufacture of Kralastic plastic materials.

Jacobson Nut Mfg. Corp. has announced that ground has been broken for a new plant located on Mark Rd., Kenilworth, N. J.

Rodney Metals, Inc., has opened a new office and warehouse at 4312 Pacific Way, Los Angeles 23, Calif. The new company will be known as Rodney Metals of Calif., Inc.

Trenton Plastics Laboratories, Inc., 1640 E. State St., Trenton, N. J., has been formed to produce custom formulated epoxy and modified epoxy resin compounds to serve the electrical industry.

Chrysler Corp. recently announced plans to spend more than one billion dollars in the next five years to expand its plants.

Ford Motor Co. has announced plans to construct a 1,200,000 sq ft steering gear and cold heading plant in Columbus, Ohio.

The Timken Roller Bearing Co. recently announced that the $5,000,000 appropriation for the manufacture of railway bearings will be spent at the Columbus, Ohio, plant.

E. H. Titchener and Co. has added new equipment to its plant facilities

new **Formica** watermark guarantees highest copper clad quality

The watermark now appearing in every sheet of the new Formica XXXP-36 laminated plastic positively and permanently identifies it as the high IR, cold punching sheet you purchased.

No other laminate carries such a seal of guarantee. Only FORMICA XXXP-36 gives you such a convenient visual check on quality control throughout your entire circuit fabricating process.

Here's why the new watermark is so important to you: design engineers specify Formica XXXP-36 because it alone offers the double value of (1) cold punching up to an including 1/16" thickness, and (2) one million megohms insulation resistance after 96 hours at 95° F at 90% relative humidity. Obviously production must be able to separate the cold punching XXXP-36 from the ordinary hot punching grades, and this is done simply by visual on-the-spot inspection.

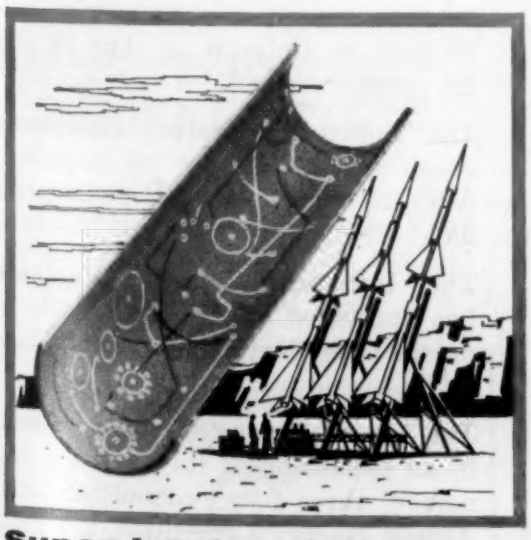
The watermark is useful to electronics manufacturers in many other ways, too. It identifies XXXP-36 as the sheet with the accuracy so indispensable to automatic printed circuit assembly.

Identification with the Formica watermark is so quick, easy and positive, it will save you real money by eliminating undependable systems of stickers, labels and front office records.

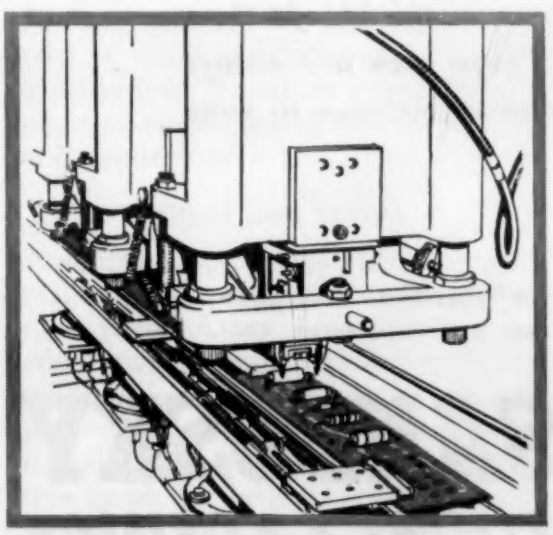
The XXXP-36 watermark is another Formica quality service that delivers *quality you can see,* for better printed circuitry. For complete information on XXXP-36 and Formica's 12 other outstanding copper clad laminates, send today for free bulletins 599 and 457 and Data Sheets.

The Formica Company
4678 Spring Grove Ave., Cincinnati 32, O.

Industrial FORMICA® Pays in Performance



Super heat resistance
—necessary for guided missiles—now available in Formica's new FF-91 epoxy type copper clad which also offers super IR, better bond strength and better all around circuit performance. (The 180° arc shown is molded.)



Automation accuracy
The uniformity required for automatic circuit assembly is provided by XXXP-36 and Formica's other cold punching copper clad laminates. Cold punching eliminates dimensional change resulting from heating.

Circuits by the yard
Formica copper clad laminates are available in more and larger sheet sizes. This greater selection eliminates unnecessary cutting, reduces waste, assures economy in fabrication no matter how large the circuit.

For more information, turn to Reader Service Card, Circle No. 428

news of | COMPANIES

in Binghamton, N. Y., in an expansion of the plating and finishing department.

Stewart-Warner Corp. has established four four-year engineering scholarships, three in mechanical engineering and one in electrical engineering, to be awarded to deserving high school graduates of exceptional ability through the National Merit Scholarship Corp. scholarship award program.

news of | SOCIETIES

The **Aluminum Assn.**, at its recent annual meeting, re-elected Everett G. Fahlman as president and Arthur V. Davis as chairman of the board. The **American Ceramic Society** has presented the first Toledo Glass and Ceramic Award to Francis C. Flint, technical director, Hazel-Atlas Glass Co.

The **American Die Casting Institute** has announced that nominations for the Doehler Award are open and will be received until April 15. The Doehler Award is made annually for an outstanding contribution to the advancement of the die casting industry or to the art of die casting.

Armour Research Foundation of Illinois Institute of Technology has inaugurated a $5,000,000 expansion program calling for the construction of three buildings and substantial additions to two buildings over the next ten years.

The **Environmental Equipment Institute's** Science Section has announced that its second annual meeting will be held in Chicago on Apr 19 and 20, 1956.

The **Industrial Heating Equipment Assn.** has elected as its president, Elton E. Staples, executive vice president, Hevi Duty Electric Co.

The **Investment Casting Institute** has appointed V. S. Lazzara, who is president of Castings Engineers, Inc., as its president.

The **Manufacturing Chemists' Assn.**, in an expansion of its activities, has named three new committees—the Atomic Energy Committee, the Education Advisory Committee and the Mechanical Technical Committee.

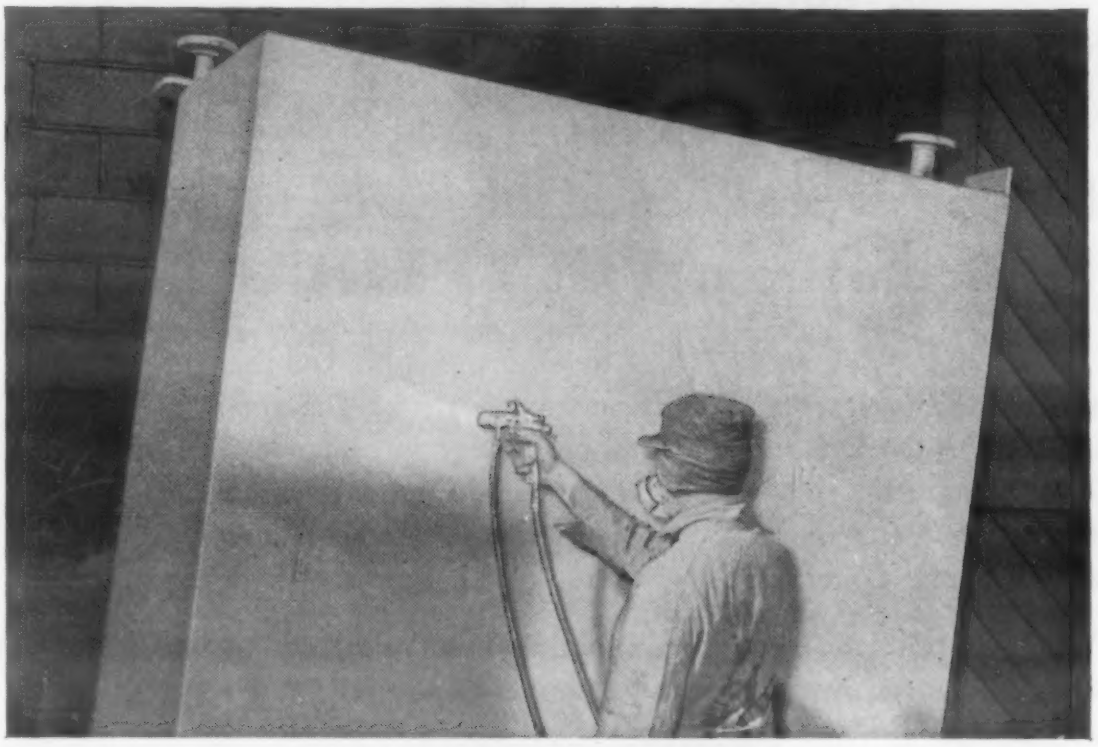
The **National Assn. of Corrosion Engineers** has selected Edward L. Si-

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New plastisol sprays extra-thick coating

Unichrome "Super 5300" Coating builds 60 mil film per coat . . . gives heavy duty corrosion-protection



Tank getting a heavy protective coating with Unichrome Plastisol. Large structural parts of products can likewise be durably finished.

A new and unusual plastisol formulation has been developed by United Chromium, a pioneer in this type of coating. Unichrome "Super 5300" Coating delivers the full solids content of vinyl plastisol right through a spray gun. It enables a coat 60 mils or more to be applied successfully in one application.

THICK AND TOUGH

Amounting to a vinyl "sheet" material, single or multiple coats of this new plastisol can be used to good advantage on many of the products where plastic or rubber sheets are generally specified. Super 5300 Coating also provides a durable, protective finish for large uneven surfaces where only a fluid material can be applied. Good performance is assured for two reasons. (1) With spraying, there are no seams or joints where corrosives might penetrate. (2) Vinyl plastisols have a unique combination of chemical and physical properties.

THE ADVANTAGES

Curing quickly at 350° to 365°, Unichrome Plastisols form rugged, resilient coatings with an attractive satin finish. They insulate electrically, absorb impact, don't chip or crack, resist abrasion and erosion, deaden sound.

They give extraordinary protection against a wide range of acids, alkalies, alcohols, salt solutions and moisture. With plastisol protection, ordinary metal parts and products often prove suitable for unusually severe service conditions.

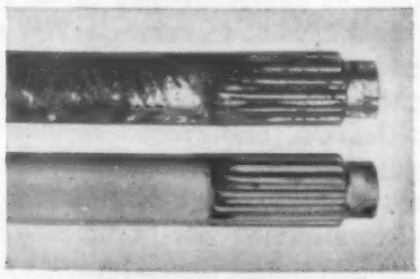
For companies without adequate baking facilities, United Chromium Division can recommend nearby firms that specialize in applying Super 5300 Coating. Send for Bulletin VP-1 that tells more about plastisols.

Crack-Free Chromium Plate solves rusting problem

The recently developed Unichrome process which deposits a chromium plate free from cracks is proving superior to ordinary chromium in certain types of applications . . . notably, where durability and protection are the prime requirements.

PROVES IDEAL IN WASHING MACHINE

Steel drive shafts in well known washing machines are now plated directly with Crack-Free Chromium about .0005" thick. Unlike *ordinary* chromium, this deposit has no microscopic cracks to admit water, humidity, soap and detergent spillage. Shafts stay rust-free, and get extra wear-resistance, besides.



With .0005" of ordinary chromium, shaft at top rusted badly after 100 hours salt spray; same thickness of Crack-Free Chromium protected shaft at bottom in same test.

Many other important protective features of Unichrome Crack-Free Chromium are detailed in Bulletin CFC-1. Send for copy.

UNITED CHROMIUM DIVISION
METAL & THERMIT CORPORATION

100 East 42nd Street, New York 17, N. Y.
Waterbury 20, Conn. • Detroit 20, Mich.
East Chicago, Ind. • Los Angeles, Calif.
In Canada: Metal & Thermit-United Chromium of Canada, Limited, Toronto 1, Ont.

For more information, turn to Reader Service Card. Circle No. 475

news of SOCIETIES

mons, a research associate in the Analytical Chemistry Unit, General Electric Research Laboratory, to receive the 1955 NACE Junior Award for his paper, "Sodium Sulfate in Gas Turbines."

The **Plastic Dispersion Assn.** has recently been formed by sixteen plastisol manufacturers.

The **Society of Automotive Engineers** has inaugurated George A. Delaney, chief engineer of General Motors' Pontiac Motor Div., as 1956 president to succeed C. G. A. Rosen.

The **Society of Plastics Engineers** has elected the following officers for 1956-57: president—Jerome Formo, Minneapolis-Honeywell Corp.; vice president—Jules Lindau, Southern Plastic Corp.; secretary—Peter Simmons, Dow Chemical Co.; and treasurer—Wayne Pribble, Pribble Plastics.

The **Society of the Plastics Industry** has appointed Walter J. A. Connor, vice president and director, American Plastics Corp., as chairman of the technical conference on plastics to be held in conjunction with the Seventh National Plastics Exposition.

The American Institute of Mining and Metallurgical Engineers has declared Grover J. Holt, general manager of the Ore-Mining Department, Cleveland-Cliffs Iron Co., officially elected as president-elect of the Institute in 1956, to serve in 1957 as president. Lloyd E. Elkins, director of production research, Stanolind Oil and Gas Co., and Joseph L. Gillson, geologist in the Development Department, E. I. du Pont de Nemours & Co., were named vice-presidents.

In addition, the Institute announced that among many awards to be made at the annual meeting in New York in February, the following would be presented: The James Douglas Gold Medal will be given to Charles R. Kuzell, general manager, Phelps Dodge Corp., "for outstanding contributions to nonferrous metallurgy, particularly in the field of copper smelting; for inspiring and guiding young engineers; and for notable service to his professional Society." Stephen M. Jenks, assistant executive vice-president, operations, United States Steel Corp., will receive the Benjamin F. Fairless Award "for his outstanding accomplishment and leadership in increasing production in his company and

news of | SOCIETIES

in the industry." The Mathewson Gold Medals will be granted to Jack Washburn, assistant professor of metallurgy, University of California, to Earl R. Parker, associate professor of physical metallurgy, and to Eugene H. Edwards for a series of four papers representing the most outstanding contribution to metallurgical science in the period under review. The J. E. Johnson, Jr., Award will be presented to M. O. Holowaty, chief of Raw Materials Research and Development Department, Inland Steel Co., "for his contribution to the literature with respect to the studies made in improving the permeability and productivity of the modern sintering process." T. R. A. Davey will receive the Extractive Metallurgy Division Award for a series of papers judged best in their field for the period under review. The Robert W. Hunt Award of the AIME will be given to Otwin Cuscoleca, technical director, Alpine Montan, Leoben, Peter Tunnerstrasse, Austria.

The **American Rocket Society**, at its annual meeting in Chicago, elected as president, Dr. Noah S. Davis, manager of the Special Products Department, Becco Chemical Div., Food Machinery and Chemical Corp.

The **Metal Powder Assn.**, repeating an award made last year, has announced the availability of a $500 scholarship in powder metallurgy for the school year 1956-1957.

The **Metal Treating Institute**, at its annual meeting in Philadelphia, Oct. 14-16, presented L. L. McArthur, chief metallurgist, and E. H. Kinne, assistant supervisor, Rollway Bearing Co., Inc., the Annual Metal Treating Institute Achievement Award for joint authorship of their article published in *Metal Treating* and entitled, "Dimensional Control System Minimizes Finishing Costs." An honorary life membership in the Institute was also presented to Fred Heinzelman, Sr., Fred Heinzelman & Sons, in recognition of 22 years of continuous membership and his many contributions to the organization.

In addition, the following officers were elected at the Institute's business meeting: president—H. N. Bosworth, Bosworth Steel Treating Co.; vice-president—K. U. Jenks, Lindberg Steel Treating Co., Inc.; treasurer—L. G. Field, Greenman Steel Treating Co.

(More News on p. 232)

one must set the example

. . . and with high speed steel it's REX

It's a real satisfaction when you set the example by what you make . . . when it becomes a *standard for comparison.* That's why Crucible is proud to have kept REX high speed steel tops in its class for so many years.

But don't take our word for REX's superiority. Try it on your own work. Compare its structure, finish, hardenability, carbide distribution and general uniformity. You'll see for yourself why it's the *standard* wherever high speed steels are used.

Remember, REX is made only by Crucible. So call for REX at your nearby Crucible warehouse, or for quick mill delivery — *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

For more information, turn to Reader Service Card, Circle No. 500

news of | SOCIETIES

The **National Electrical Manufacturers Assn.** has elected J. W. Corey, president, The Reliance Electric & Engineering Co., as president to succeed Albert F. Metz, chairman of the board and chief executive officer, Okonite Co. The following vice presidents were also elected: F. F. Loock, president, Allen Bradley Co., J. J. Mullen, Jr., president, Moloney Electric Co., B. C. Neece, president, Landers, Frary & Clark, W. V. O'Brien, vice president and general manager, Apparatus Sales, General Electric Co., and J. L. Singleton, vice president, Industries Group, Allis Chalmers Manufacturing Co.

The **National Metal Trades Assn.** has made J. L. Robinson, vice president and director of Jabez Burns & Sons, Inc., its president to succeed Earle S. Day, vice-president and general manager, Collyer Insulated Wire Co. Walter F. Newhouse, vice-president and general manager, Saranac Machine Co., was named first vice-president, and Herbert M. Ramel, vice president, Moog Industries, Inc., was elected second vice-president and treasurer.

The **Pressed Metal Institute** elected the following officers at its recent annual meeting: president—Joseph J. Boehm, The Boehm Pressed Steel Co.; vice presidents—Bruce Krasberg, R. Krasberg & Sons Mfg. Co., and C. E. Stryker, Maysteel Products, Inc.; secretary-treasurer—W. B. Gemmill, The American Stamping Co.

United Engineering Trustees, Inc., has named Walter J. Barrett as president for the ensuing year. Other officers elected by UET include Willis F. Thompson and A. B. Kinzel, vice presidents, Joseph L. Kopf, treasurer, George W. Burpee, assistant treasurer, and John H. R. Arms, secretary and general manager.

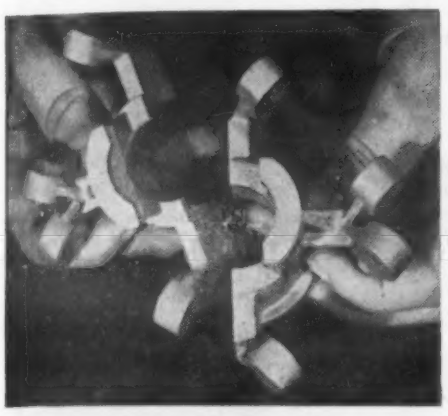
The **National Science Foundation** has named Detlev W. Bronk, president of the Rockefeller Institute for Medical Research, as chairman of its governing body, the National Science Board. The Foundation has also announced the election of Paul M. Gross, vice president and dean of Duke University, as vice chairman of the Board and chairman of the Executive Committee.

The **Porcelain Enamel Institute** has engaged Eugene D. Mulligan to fill the newly-created position of administrative assistant.

(Meetings & Expositions on p. 234)

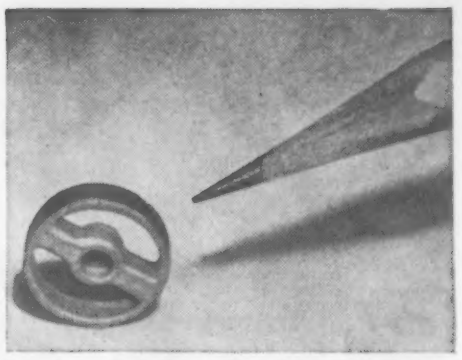
1. Cut costs up to 60%

When precision cast by Inco, these two trigger parts of a powder-actuated fastening tool cost the tool manufacturer *half* what they would have cost if machined from bar stock. *Instead of twenty machining operations he makes only two!*

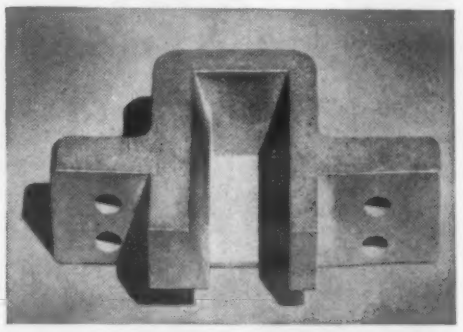


2. Wider design latitude Formerly, made in six parts, this stabilizer collar for a sonar device had to be assembled with screws. Inco precision casts it in *two parts*, simplifying and improving the design, cutting cost with fewer production and assembly steps.

3. Little or no machining required A milk-bottle capping machine has 6 of these stainless steel wedges. Once, each took 13 machining operations (more — counting rough and finish cuts). When precision cast by Inco, each needs only 9 machining operations — four of them light, finish cuts. *Net saving in machining time is 75%.*



4. Higher alloys at lower cost To protect color and flavor, the manufacturer of a liquor dispensing system wanted to make this collet head of Inconel* nickel-chromium alloy. Machined from bar stock, it needed 10 operations (and half the bar ended as scrap). Now, Inco precision casting makes the use of Inconel alloy practical, *cuts cost 30%.*



5. Longer life with harder alloys This latch for a commercial laundry machine must be strong and hard, resist galling and corrosion. "S" Monel* hard-grade nickel-copper cast alloy seemed the logical choice, but all the forging, broaching, soldering, drilling and facing ruled it out. However, Inco precision cast the latch so only finish machining is needed. Now, this alloy is practical to use.

Got a tricky small part?

...*Inco Precision Casting offers* 5 Big Advantages

Do you have a part which is 6 inches by 5 inches or smaller? Does it weigh under 3 pounds? Require starting tolerances as close as plus or minus .005 inch per linear inch? And need 5 or more fabrication steps? If the answer is *YES*, down the line, there's a good chance you can cut costs drastically, and achieve design advantages at the same time, by having it *precision investment cast* by Inco.

*Registered trademark of The International Nickel Company, Inc.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

Get This Helpful New Booklet

Trying to keep costs in line on some small part? Then write for new 16-page booklet, "Cast to Outlast." Contains many case histories detailing how others cut costs with Inco precision casting. There is a good chance this helpful data will suggest a practical way to cut your costs, too.

INCO TRADE MARK

Inco Castings *Precision • Sand • Centrifugal*

For more information, turn to Reader Service Card, Circle No. 338

Meetings and Expositions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div. conference. Princeton, N. J. Mar 26-28, 1956.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic meeting, production forum and aircraft engineering display. New York. Apr 9-12, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Machine Design Div. conference. Worcester, Mass. Apr 10-11, 1956.

METAL POWDER ASSN., annual meeting and metal powder show. Cleveland. Apr 10-12, 1956.

MALLEABLE FOUNDER'S SOCIETY, annual market development conference. Chicago. Apr 12-13, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Gas Turbine Power Div. conference. Washington, D.C. Apr 16-17, 1956.

AMERICAN CERAMIC SOCIETY. New York. Apr 22-26, 1956.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention and exhibition. Atlantic City. May 3-9, 1956.

AMERICAN WELDING SOCIETY, national spring meeting and 4th welding and allied industry exposition. Buffalo, N. Y. May 8-11, 1956.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. Atlantic City. June 3-8, 1956.

MALLEABLE FOUNDERS' SOCIETY, general meeting. Hot springs, Va. June 11-12, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Applied Mechanics Div. conference. Urbana, Ill. June 14-16, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Cleveland. June 17-21, 1956.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City. June 18-22, 1956.

ALLOY CASTING INSTITUTE, annual meeting. Hot Springs, Va. June 24-26, 1956.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer and Pacific general meeting. San Francisco. June 25-29, 1956.

DESIGN ENGINEERING SHOW, exposition and conference. Philadelphia. May 14-17, 1956.

SOCIETY OF THE PLASTICS INDUSTRY, seventh national plastics exposition. New York. June 11-15, 1956.

MATERIALS ENGINEERING NEWS

INSPECTION SYSTEM

Continued from p. 11

tion for quality control of production. In this plant a thermal heating element, 1 in. dia by 2½ in. long, was being inspected with a conventional fluoroscope running at 110 kvp. Windings in the element could not be distinguished, but 3/16-in. or larger voids in the ceramic thermal shield could be detected. Reject rate had been averaging 2%. The inspection process required alternating operators working in a dark room throughout the day.

With the GE image system, the voltage needed for penetration of the object was lowered to 70 kvp, a drop of 40 kvp. The x-ray image of the product was increased to five times normal size with the individual windings distinct under normal room illumination. Voids averaging 1/16 in. dia in immediate contact with the wire could easily be seen. This increased detail perception caused the reject rate to jump to 25%, necessitating a redesign of the product for better quality.

Automatic inspection

The new system can be adapted to automatic inspection by using an "absorption negative" of the object being examined. Automatic trip circuits can then detect and reject any object having a defect recognizable by a change in transmission. Inspection systems of the future utilizing these tubes will be so constructed that the absorption negative will eliminate the need to display the completed image on a monitor tube.

(More News on p. 241)

Don't forget the
DESIGN ENGINEERING SHOW
Philadelphia Convention Hall
May 14-17.

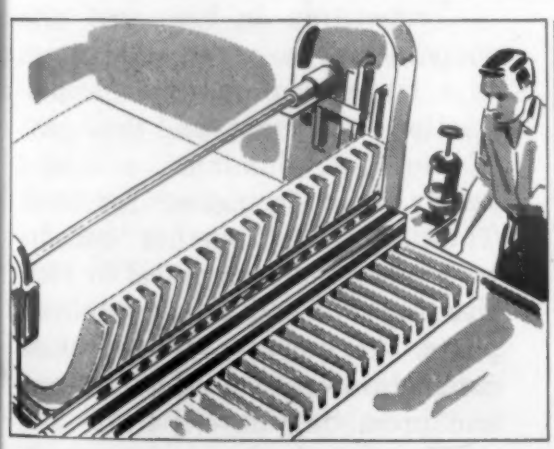
Takes 6 Million Flexes (50% compression) —with no breakdown—and you can order urethane foams in a range of resiliencies; in densities from 2 to 8 lbs. per cu. ft.

Cushioning . . . with Urethane Foams

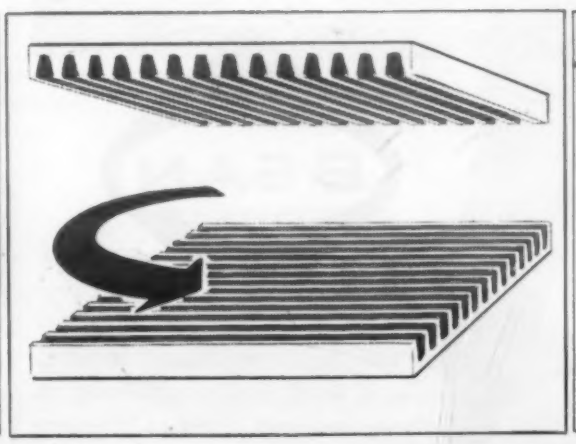
Flexible, shock-, sound-, heat-absorbing urethane foams —a totally new material for industry—are available now to make startling improvements in seating design and greatly simplify the manufacture. Colorful urethane foams:

- *Have open cells — they breathe!*
- *Can be band-sawed, stamped, cut with hot wire.*
- *Can be stapled or hog-ringed directly to wood or springs.*
- *Can be stitched or glued to fabric.*
- *Can be custom molded directly into arm rests, head rests, or shapes as large as automobile door and roof liners.*

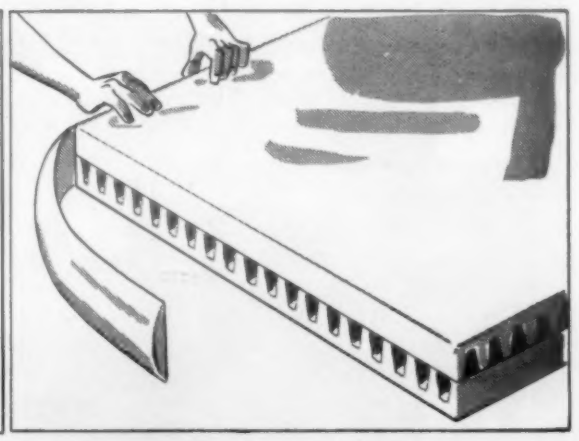
Upholstered furniture without springs!



1. Fed automatically through a shaped wire die, the electrically heated nichrome wire cuts foam section into scalloped halves . . .



2. Halves are then rotated a quarter-turn and rejoined with scallops criss-crossed to form air pockets for cored cushioning. Degree of softness is controlled by shape of scalloping, by specifying the desired compression-deflection of the foam.



3. Hot wire, profile-cut edging fastens permanently with self-curing urethane adhesive . . . bonds foam to wood, metal, leather, vinyl, or fabric.

Nichrome: Registered Trademark of Driver-Harris Co.

Monsanto does not make urethane foams—only the chemical raw materials that go into them. However, Monsanto would be happy to send you a list of companies who can supply you with samples, specific information on available properties and prices. Write: Organic Chemicals Division, MONSANTO CHEMICAL COMPANY, Dept. ID-1, St. Louis 1, Mo.

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MONSANTO

For more information, turn to Reader Service Card, Circle No. 513

MATERIALS ENGINEERING NEWS

ALUMINUM, STEEL COMPETITION

Continued from p. 12

peratures because of their high thermal conductivity which permits faster removal of heat.

Expanding applications

Optimum methods of design and fabrication for aluminum developed by the aircraft industry offer guides to other applications. Particularly significant here are the stressed-skin construction and the use of nonmetallic bonding materials in place of welding or riveting. Lightweight construction is spreading rapidly into other fields, with increasing use of aluminum in ships, trains and trailers where it permits greater load carrying capacities. In recent years the construction industry has used more aluminum not only for parts such as window frames but also for sheathing. Cooking utensils and chemical equipment are other examples of aluminum's expanding use.

Competition is tempered with cooperation, however. Aluminum is a large user of steel for production equipment, and thousands of tons of aluminum are used yearly as a deoxidizer for steel. That working together benefits both metals is exemplified by steel wearing plates on aluminum parts, steel cores for aluminum conductors and—a relatively new and promising development—aluminum-clad steel.

Production ratios

Aluminum, however, must take a backseat to steel in both price and production. While the price of aluminum relative to steel has declined over the past 30 years, it is still several times higher. In world production, aluminum is approximately 1% of steel on a weight basis and only 3% on a volume basis, and it is unlikely that this ratio will change in the near future.

(More News on p. 241)

MATERIALS ENGINEERING NEWS

Metalworking Ready for Automatic Control

About 16% of all manufacturing operations in the metalworking industries could be taken over by automatic control devices, according to a study by the American Society of Tool Engineers. More surprising: the survey concludes that automatic control is less adaptable to large plants than to medium size plants.

Metal forming

In metal forming, the automatic control potential for all of the industry is estimated at slightly below 20%. Plants with 250 to 1000 workers show a 25% average with smallest and largest plants averaging out to around 10% and 15% respectively.

The smallest plants, those below 250 employees, seem to feel that they can do just as well by modifying metal forming equipment (adding automatic loaders and feeders on presses, etc.) as by replacing equipment. Plants in the next larger size group (250 to 1000 workers) believe that well over 10% of present metal forming equipment can be automatically controlled in addition to the 15% that would call for new machines.

Welding, finishing

Industry feels that slightly less than 15% of production welding operations can be automatically controlled. Averages, however, ranged from only slightly over 5% for the smallest plants to nearly 25% for the 1000- to 5000-worker plants. The ratio favoring achievement of automatic control "by-purchase-of-new-equipment" as against "modifying-existing-machines" is about two to one. In the large group of 1000- to 5000-worker plants the ratio is three to one.

Somewhat better than 15% of all grinding and finishing operations can be automatically controlled. The averages range from less than 10% for the smallest plants to well over 20% for the

MATERIALS ENGINEERING NEWS

250- to 1000-worker plants. For these operations the average ratio favoring "purchase" over "modify" is about two to one, but in the largest plants it is almost five to one.

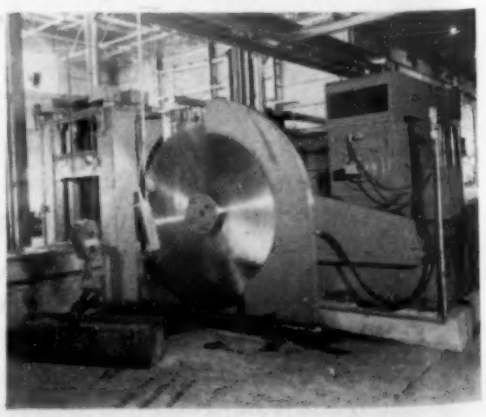
Inspection operations

Automatic control could be applied to about 17% of inspection methods. The highest average estimate—slightly below 25%—is in the 250- and 1000-worker plants, with smallest plants averaging better than 10%. Ratio is two to one in favor of buying as against modifying. Largest plants (over 5000 workers) figure that better than 15% of their inspection methods can be automatically controlled. However, over two-thirds of the operations would require new equipment.

In addition to metal assembly operations, other type of production operations mentioned in the ASTE survey as amenable to automatic control are:

1. 50% of plastic molding operations.
2. 50% of permanent mold castings.
3. 100% of heat treating.
4. 70% of foundry operations.
5. 50 to 60% of final cleaning and painting operations.

(More News on p. 244)



Aluminum saw. *Located at a U. S. Air Force plant in Cleveland, this 7-ft saw is used to cut aluminum forging ingots up to 3½ ft thick. Cutting speed is adjusted to the grade of aluminum being cut. The saw's variable speed drive provides ranges from 1360 to 4100 fpm.* *(General Electric Co.)*

A valve disc sleeve used in the air release mechanism of a Neptune Red Seal petroleum meter was originally made of brass rod stock, then of die-cast zinc (which proved unsatisfactory) and now of powdered brass. Tolerances are ±.001" on two diameters. The part costs no more than the unsatisfactory die casting and approximately ⅓ that of the machined part.

This oil pump rotor is used in several IBM machines. Saving in cost as compared with machined parts, says IBM, is 84%! Total tolerances of .001" and .002" are required. Powder metal processing eliminates all machining operations, which previously required 20 hours per 100 pieces.

Making this intermediate wringer-drive gear of iron and copper powder saves its user, the Whirlpool Corporation, St. Joseph, Michigan, up to $20,000 per year. The part was formerly made from a ⅜" blank which was pierced, flattened, machined for teeth; wire brushed for burr. Tolerances on the powder metal part are identical with those obtained by machining.

The Stokes 300-ton Model 713 hydraulic powder metal press, a recent addition to the complete line of 16 Stokes fully automatic powder metal presses of 1½ to 500 tons capacity. Powder metal presses of the modern Stokes' line embody THIRTY YEARS of powder metal press research and engineering.

The parts illustrated on this page are made by the Presmet Corporation, Worcester, Mass., custom maker of high-precision powder metal parts . . . like most producers of powder metal parts, a user of Stokes powder metal presses.

Powder Metal Processing

Saves $20,000 a Year on this Part

Parts which are difficult to machine . . . parts which are wasteful of solid metal . . . are made in powder metal at great savings.

Fully automatic compacting of a broad selection of metal powders, pure or mixed, gives wide flexibility in determining tolerances, tensile strength, and functional characteristics, many of them unattainable in solid metal.

Stokes has over thirty years' experience in making presses *specifically* for powder metal processing. Stokes engineers are recognized for their broad contributions to the growing success of powder metal processing . . . will gladly contribute their experience to manufacturers interested in powder metal processing as a means of cutting costs and improving products.

Three booklets available: "Powder Metallurgy Today"; catalog of Powder Metal Presses (#801); and "How to Save Money on Punches and Dies". Send for any or all.

F. J. Stokes Machine Company
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STOKES

ENGINEERS:
Stokes is continually adding to its engineering and technical sales staffs in the high vacuum, industrial tabletting, powder metal and plastics molding fields. If you can qualify, there may be a position for you.

For more information, turn to Reader Service Card, Circle No. 466

MATERIALS ENGINEERING NEWS

Electronic stop watch. *Photomultiplier tube allows scientists to time events to less than one billionth of a second. Light can circle the earth 7 times in 1 sec, but during the shortest interval measured by the electronic stop watch, light can travel no more than a few inches.*

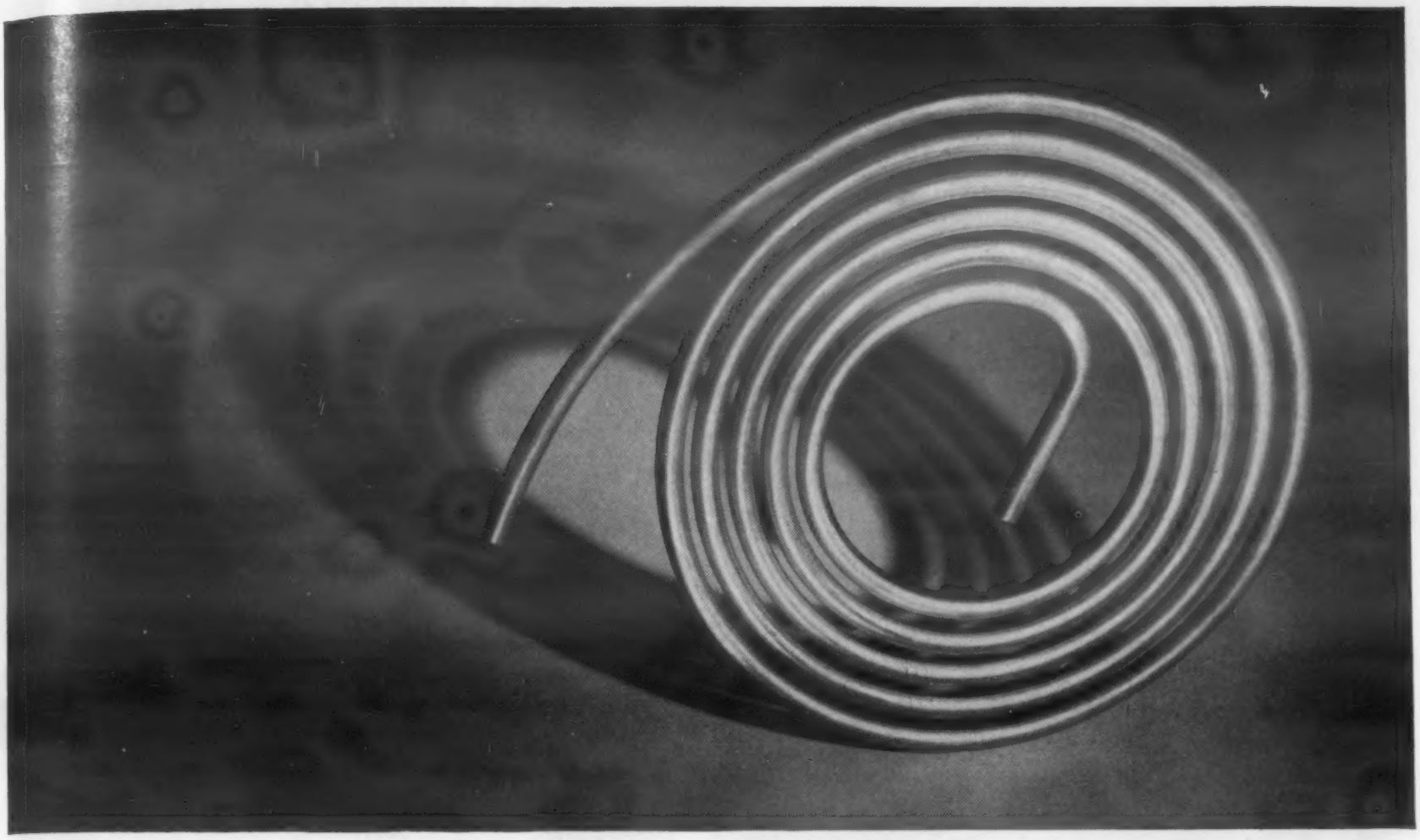
(Westinghouse Electric Corp.)

Thirty-eight Stories Without A Rivet

All 13,000 tons of steel to be used in a new 38-story skyscraper in New York City will be bolted together instead of riveted. The bolting method makes possible a substantial saving in time and labor in addition to eliminating the din caused by riveting.

Making use of a special high carbon steel bolt held in place by a nut and washer the bolting method has been used successfully in bridge and industrial plant construction. The strength of the bolt makes possible a clamping power unobtainable by riveting, and wrenches are the only tools necessary. The bolts require only half the number of men needed to drive rivets; a two man team can assemble and tighten approximately 400 bolts in one working day compared with the 300 rivets that can be placed by a four man riveting crew.

(More News on p. 246)



Superior offers the widest range of sizes and alloys in top quality instrument tubing

Superior Tube Company produces the finest instrument tubing in a wide range of sizes and alloys—offers you as standard products what many makers would classifiy as specialty tubing.

1. NEEDLE TUBING

The stainless steel links in this recording instrument are made of Superior needle tubing. The high strength, stiffness, and strict dimensional tolerances characterizing this tubing—originally designed for surgical uses—have opened new fields of industrial applications when used as mechanical tubing.

2. PRESSURE AND SUPER PRESSURE TUBING

A spiral windpipe made of Superior 304 cold-drawn seamless stainless steel tubing. Pressure tubes are used to convey fluids at elevated temperatures and pressures. Produced in stainless, carbon and alloy steels in sizes to withstand pressures up to 100,000 psi.

3. BOURDON TUBING

A "C" tube element for a pressure gage. The shaped Bourdon tube serves as the actuating element for the majority of pressure indicating and recording instruments. Helix and spiral elements are also fabricated from the wide range of alloys available at Superior—a range that makes it possible to satisfy any set of conditions in the use of Bourdon tubing.

4. CAPILLARY TUBING

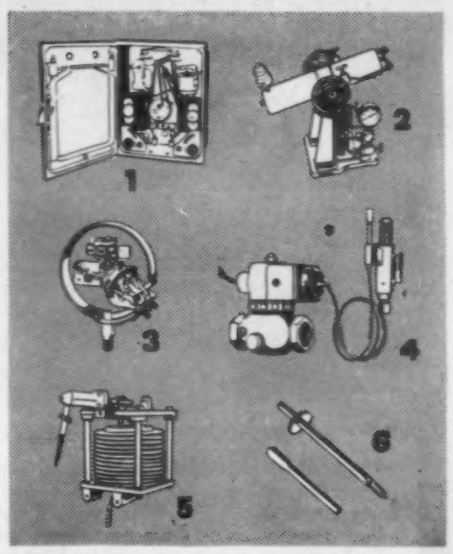
A thermostatic instrument pressure transmission element with a coiled unit made of Superior Type 321, capillary tubing. Superior capillary tubing is used primarily for transmitting temperature and pressure impulses from the source to a recording or indicating instrument. Capillary purposes, in general, require a heavy-wall tube with an ID of .006″ to .030″. Types 347, 321, 316, MONEL* and carbon steels are recommended analyses.

5. LARGE OD LIGHT WALL TUBING

A large OD light wall tubing bellows in a pressure actuating element. Present applications for large OD light wall tubing include bellows, low pressure heat exchanger tubes, flexible hose, aircraft ducting, fractional horsepower motor casings, ceramic drills, and casings for radioactive well logging instruments. Sizes offered up to 2½″ OD.

6. MECHANICAL TUBING—INSTRUMENT LINE

Various fabricated parts—all made of Superior mechanical tubing. Superior mechanical tubing can be either seamless or WELDRAWN† grade used statically or dynamically, but not subjected to severe temperature or pressure. It is produced in sizes up to ⅝″ OD within production limits, in many special shapes, and in over 63 standard analyses and mechanical properties.



Send for free copy of Bulletin 40—A Guide to the Selection and Application of Superior Tubing. Write Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Round and shaped tubing available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium

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The big name in small tubing

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All analyses .010″ to ⅝″ OD—certain analyses in light walls up to 2½″ OD

*Reg. T.M. International Nickel Co.
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On the West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif.

For more information, turn to Reader Service Card, Circle No. 498

MATERIALS ENGINEERING NEWS

Engineers Push Sheet Metal Standard

"The industrial consumer who is alert to the benefits of standardization is unable, in many cases, to purchase sheet metal to the thicknesses listed in the American Standard, B32.1-1952" according to F. M. Oberlander, Manager of Materials Standards for Radio Corp. of America. Oberlander was one of several speakers who discussed consumer problems in the purchase of sheet metal at the Fourth Annual Convention of the Standards Engineers' Society held recently in Hartford, Conn.

I. V. Williams, Bell Telephone Laboratories, explained that the American Standard was developed following a request by the Society of Automotive Engineers for unification of the many gage systems by which metal sheets and plates have been identified in the past. Purpose of the standard was to designate thicknesses of metal sheets in decimals. It established a series of preferred thicknesses for thin flat metals under 0.250 in.

Cooperation needed

A number of difficulties have been encountered in putting the standard into use. One is that material to the old gage sizes must be used during a transition period. Another is in trying to purchase material to preferred thicknesses from warehouse stocks. To meet the first difficulty the standard was revised in 1952 and additional sizes were listed as preferred thicknesses. "It is now possible," Williams explained, "to choose a preferred thickness which is within a few thousandths of an inch or less of most of the thicknesses now commonly used."

To meet the second difficulty, Mr. Williams advocated the method followed by the Eastern Division of the National Aircraft Standards Committee which reached agreement with a group

MATERIALS ENGINEERING NEWS

of warehousemen in New York. The aircraft companies agreed to accept sheet steel to the nearest manufacturers' gage until new material was ordered by the warehouse. The warehousemen, on the other hand, agreed to order new material to standard preferred thicknesses. Procurement in small quantities remains the major problem, particularly in areas where industry is diversified and there is no organization to speak for the groups concerned.

Large vs small

Charles M. Parker, Assistant Vice-President of the American Iron and Steel Institute, also considered the problem to be of greatest concern to those who order less than carload lots. At present about 6 to 8% of the sheet steel ordered is rolled to the preferred thickness standard, he said. These orders are mostly from the larger companies which order in heat lots or more and present no problem to the mill.

"The steel industry prefers decimal thicknesses to be used rather than gage numbers," Parker said. "We do, of course, use the Manufacturers' Standard Gage for the production of sheet steel, a gage which was established by the Association of American Steel Manufacturers' Technical Committees in 1929."

Any concerted movement to increase the popularity of the preferred thickness standard must of necessity come from the consumer, he declared, since the warehouses stock what their customers want to buy.

The brass mill industry makes it convenient to use American Standard Preferred Thicknesses for Uncoated Thin Flat Metals, B32.1-1955, by adding the preferred sizes as Table 1 in its schedule DATA-1. It does not recommend the use of gage numbers. This was the report of T. E. Veltfort, Manager, Copper and Brass Research Assn. Economies result-

By using a laminate with "Mylar", the Burgess Battery Co. has developed a strong, thin envelope (left), which seals in the tiny cells of their new, more powerful batteries. Fifteen cells are stacked in a column, overwrapped in the same laminate with "Mylar" (center), then capped with a tube (right).

Du Pont MYLAR® helps Burgess obtain smaller, more powerful batteries

"Smaller than your finger tip, yet a third more powerful than conventional cells . . . that's the story of improvement on our line of dry-cell batteries", reports the Burgess Battery Company, Freeport, Ill. "We achieved this improvement by using a laminate with 'Mylar'* formed into an envelope to seal in tiny dry cells. Because the lamination is extremely thin, we saved valuable space for more energy-producing materials.

"By using this same laminate with 'Mylar' as the insulating cell-stack wrap, the old problem of holes appearing in the overwrap after heat sealing has been completely eliminated. High chemical resistance and strength make it possible to heat-mold each cell into a permanent locked position to preserve the intercell connection. What's more, the transparent material permits maximum quality control . . . inspectors can see into each cell stack to insure perfect stacking and wrapping."

This is only one example of the way versatile Du Pont "Mylar" polyester film, used alone or in combination with other materials, is making possible superior performance for a variety of electrical products.

For more information on how "Mylar" can help you improve product performance, or solve knotty problems, send in the coupon below. Be sure to indicate the type of application you have in mind.

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Application_____

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MATERIALS ENGINEERING NEWS

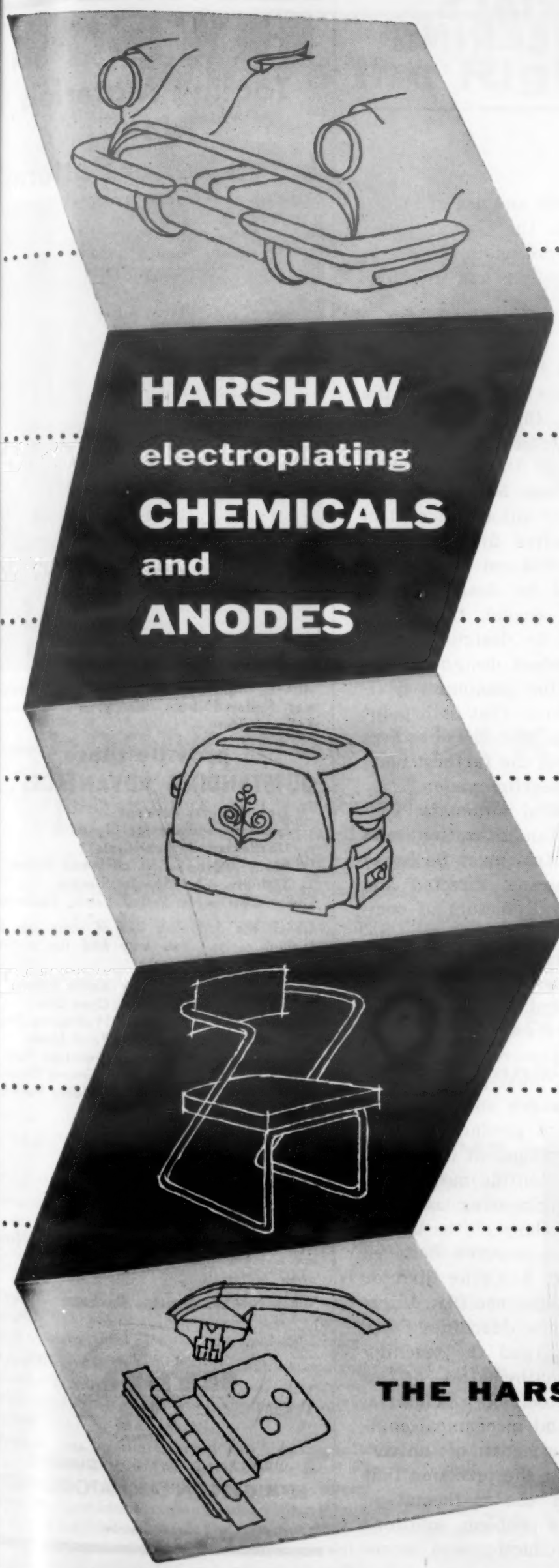
ing from the use of the preferred sizes must await the demand for these sizes. He recommended that design engineers be encouraged to adapt the preferred sizes to their requirements.

Inventory control

The turnover of all inventory by the 517 member companies of the American Steel Warehouse Assn. was less than two times per year, R. Shaw reported on behalf of the warehousemen. Steel warehouses as a group distribute almost 20% of the total finished steel output in this country, approximately 15 million tons of steel, he said. The problem of inventory control created by a multiplicity of sizes, thicknesses, and grades gives the warehousemen a special interest in the standard.

Customers, as well as producers and distributors, order the newer metals—aluminum and magnesium—by decimal thickness. Shaw proposed that orders of cold rolled carbon steel sheet and stainless steel sheet be filled by shipping the standard gage nearest to the preferred thickness, since there is a wide allowable manufacturing tolerance variation in these two products that makes it possible to correlate many of the gage variations with the preferred thickness standards. Over a period of time this practice would tend to bring about standardization, he believes.

The question as to whether standards should be mandatory was discussed in one session of the conference. Cyril Ainsworth, Technical Director and Assistant Secretary of the American Standards Assn. pointed out that standards are fundamentally voluntary in nature. It is the purpose behind the use of a standard that created the mandatory concept and not the standard itself, he said. The combination of voluntary and mandatory aspects in



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tin plating

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zinc plating

... ball and cast zinc anodes ... sodium and zinc cyanide ... zinc sulfate ... zinc fluoborate.

lead plating

... cast lead anodes ... lead fluoborate.

silver plating

... silver cyanide.

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MATERIALS ENGINEERING NEWS

the development and use of standards has made the United States the foremost nation in the world in production, sale and distribution of goods.

Standards in automatic control

Automatic control is built upon standards but standardization can cause problems because of the need to keep the way open for new developments, said C. J. Lawson, Director of Standards, International Business Machines Corp.

A successful automatic control program requires first, he said, that standardization and automatic control be designed into the product; second, that automatic control be designed parallel to the product design and be programmed for maximum flexibility; and, third, that both point not only at the immediate project but "encompass the farthest horizons of engineering vision."

For successful automatic control, both standardization and automatic control must be broad company programs directed and supported by all factors of company management, Lawson declared. Standardization must begin on the drawing board and be carried forward to the finished product. It must be developed jointly by Engineering and Manufacturing and must provide flexibility for changes and programming for short production runs.

Further development of mathematical and scientific methods in production engineering is foreseen as a corollary of the use of the electronic computer, declared Dr. Charles R. DeCarlo, director of the Applied Science Div., International Business Machines Corp. Dr. DeCarlo urged the teaching of applied mathematics as an engineering tool by industrial engineering and mechanical engineering departments of universities. Without the precision that is implied in the mathematical treatment of a problem, solutions of complex production and inven-

What's the Right X-ray Film?

PRODUCT:
Fork lever

MATERIAL:
Steel

EQUIPMENT:
250 kv x-ray machine

Kodak Industrial X-ray Film, Type A

THIS steel fork lever was designed to take a specific load. But shrink, if present, would rob it of its strength. So the radiographer was called upon to check for soundness.

For the x-ray job he used 250 kv for 8mam at 36 inches and Kodak Industrial X-ray Film, Type A.

This film was chosen because its speed, fine grain and high contrast best met the needs of this job.

RADIOGRAPHY

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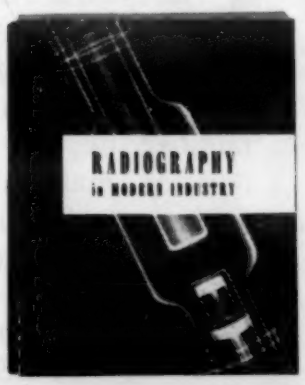
Whatever your radiographic problem, you'll find the best means of solving it in one of Kodak's four types of industrial x-ray film. This choice provides the means to check castings and welds efficiently, offers optimum results with varying alloys, thicknesses, and radiographic sources.

Type A—has high contrast and fine grain with adequate speed for study of light alloys at low voltage—heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage without use of calcium tungstate screens.

Type M—provides maximum radiographic sensitivity with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multimillion-volt work.



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MATERIALS ENGINEERING NEWS

tory problems would be hopeless, even in the presence of the largest and most powerful computer man will ever be able to build, he said.

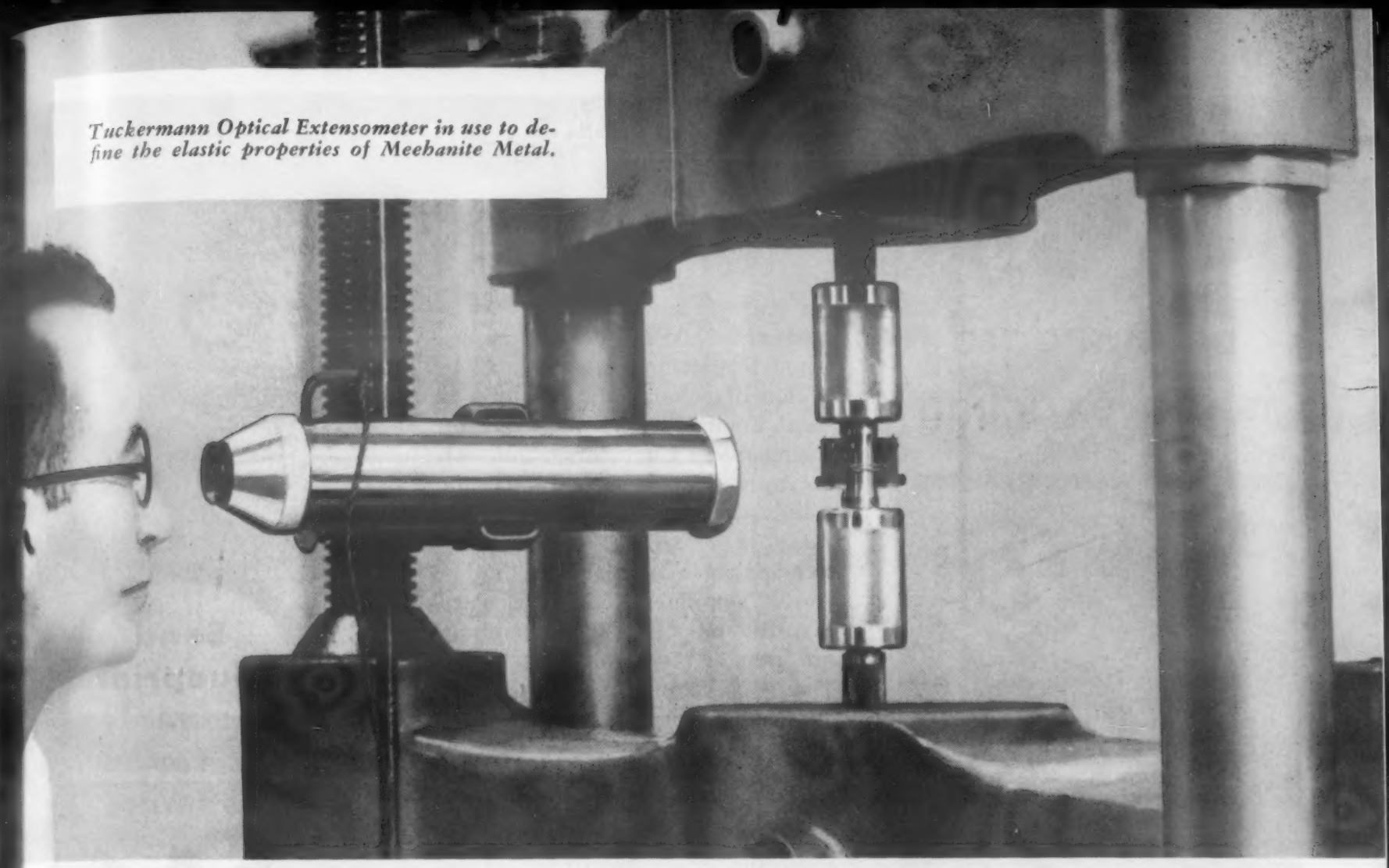
The electronic computer has abilities which make it well equipped to solve many of the complex problems that beset production and inventory management, DeCarlo explained. These abilities are:

1. Handling large volumes of information rapidly both in reading and writing speeds.
2. Handling large number of variables simultaneously.
3. Performing high-speed arithmetic operations.
4. Performing logical choices.
5. Enumerating a large set of possible actions.
6. Operating in stochastic processes; i.e., evaluating probability distributions, storing density functions, generating random numbers for entry into such tables, and computing by repeated trial the expected value of a variable phenomenon or a sum of variable phenomena.

Work of societies

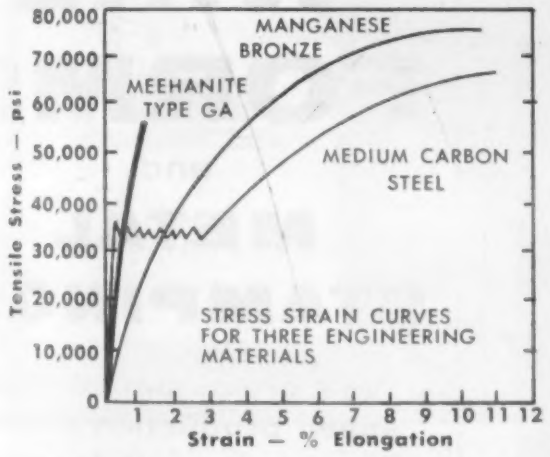
R. J. Painter, Executive Secretary of the American Society for Testing Materials, called attention to the fact that ASTM standards double in number about every 10 or 12 years. Today there are more than 2200 ASTM standards; in 1928 there were 500. Recently, ASTM activities have entered a number of new fields, such as plastics, materials for electronic devices, hydraulic fluids, carbon black, super alloys and radioactive isotopes.

He particularly emphasized, however, that ASTM is not solely a standards organization, but is a research and standards organization. Work on standards is not good without the necessary facts to back it up, he pointed out, and, conversely, adequate standards of comparison are needed to evaluate the products of research. A great



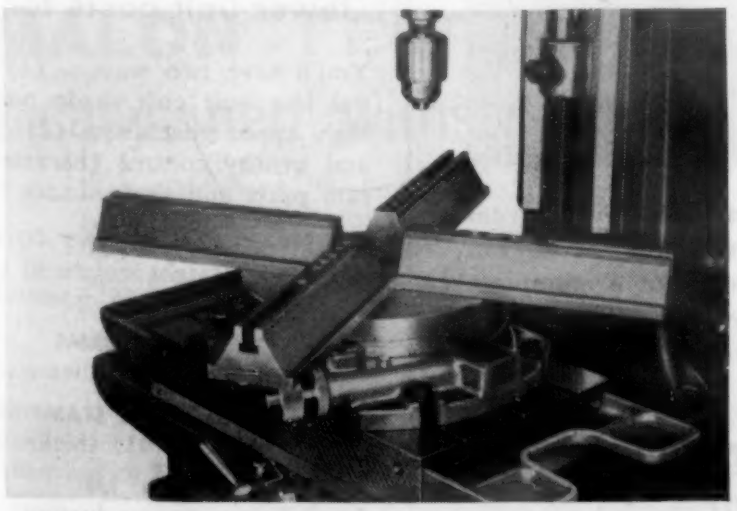
Tuckermann Optical Extensometer in use to define the elastic properties of Meehanite Metal.

MEEHANITE METAL PROVIDES DEFINED ELASTIC MODULUS VALUES FOR THE DESIGN ENGINEER

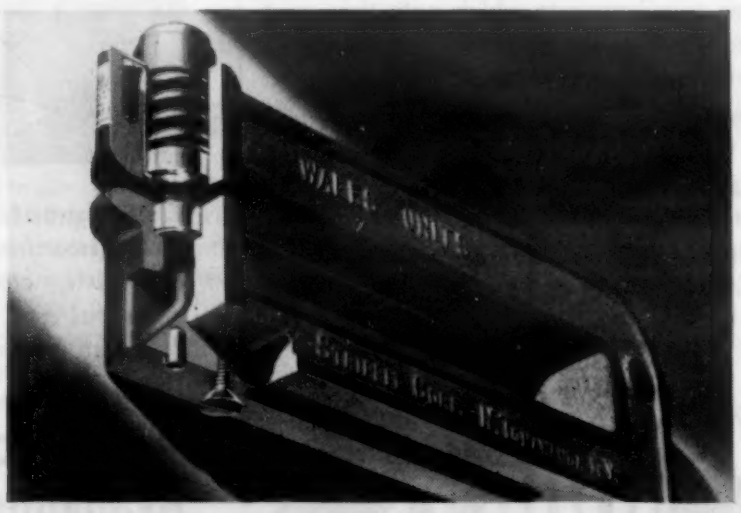


Meehanite Castings have true elastic property characteristics. Results of test data obtained from the use of sensitive strain gages have established modulus values ranging from 22,000,000 to 17,000,000 psi according to the type of Meehanite Metal. Modulus of elasticity for Type GM is 22,000,000 psi; Type GA 20,000,000 psi; Type GB 18,000,000 psi; Type GC 17,000,000 psi.

The data also demonstrates that true elasticity persists up to loads approximating one-third of the tensile strength of the metal. Design with confidence. Specify Meehanite Metal for your casting requirements. For additional information, write for Meehanite Design Data, Bulletins No. 26 and No. 27 today.



High modulus with resistance to elastic deformation is important in these Meehanite extension parallels where maintenance of required dimensions is essential.



Dimensional stability and high resilience of Meehanite Castings is typified in this Wales Hole Punching unit. The superior stiffness of Meehanite Metal permitted units to be made with 8", 12" and even 16" throats.

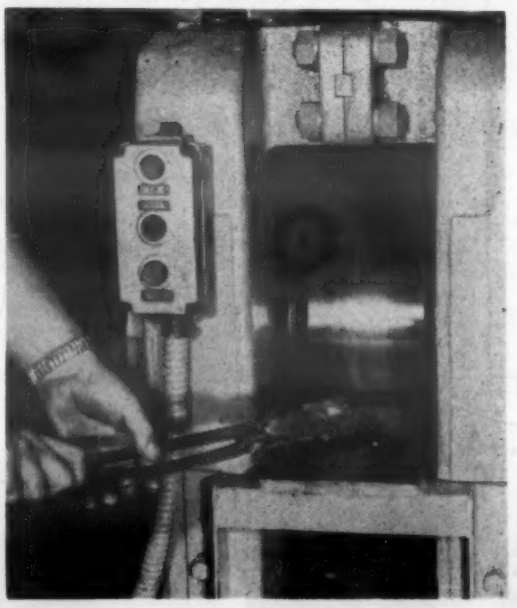
MEEHANITE METAL®

MEEHANITE METAL CORPORATION • NEW ROCHELLE • NEW YORK

MATERIALS ENGINEERING NEWS

portion of ASTM's work is devoted to getting facts.

Don Blanchard, Manager, Technical Committee Div., Society of Automotive Engineers, told of the work the Society has done on standards during 45 of its 50 years of existence. Since 1940, in addition to standards for automotive equipment, SAE has been carrying on a rapidly expanding program in the aeronautical field. The 1914 volume of SAE Standards had 50 pages; the 1955 edition has 1094 pages. SAE cooperates on committees of the ASTM; the American Society of Mechanical Engineers; and the American Iron and Steel Institute. It is sponsor for five ASA sectional committees and participates in the work of 30 committees.



***Experimental mill** rolls sheet from small titanium ingots. Sheet is then annealed, cleaned and a complete chemical and physical analysis made for test purposes.*

Quality Certification Available for Titanium Fabricators

Ever since titanium metal was introduced a few years ago, fabricators have been struggling with variations in its mechanical prop-

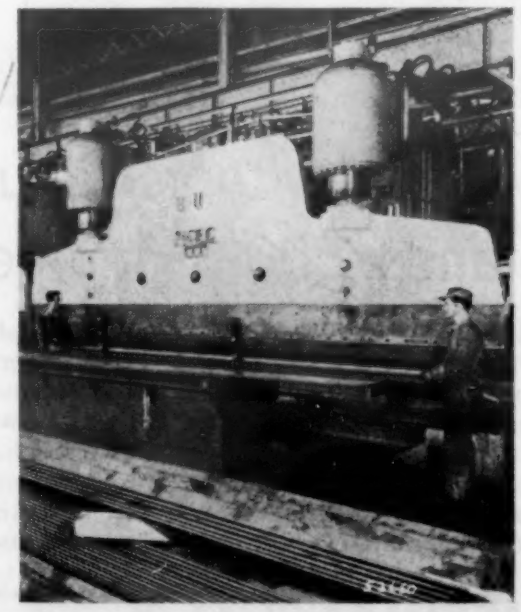
MATERIALS ENGINEERING NEWS

erties. If customer purchases of titanium mill products call for strength in a specified range, say 70,000 to 90,000 psi, it is the variability of strength within this range that makes for headaches in the shop.

Now, Mallory-Sharon Titanium Corp. will certify mechanical properties within narrow ranges. Using statistical quality control techniques to improve uniformity of unalloyed titanium sheets, Mallory-Sharon accompanies each heat of material with a report attesting to an average strength level and also to narrow limits of variability, such as plus or minus 5000 psi.

Certified properties are based on a statistical confidence level of 97.5%. With close uniformity assured, fabricators can eliminate segregating of sheets into strength level groups together with the costly procedure of setting up different dies and tooling when wide variability in strength is encountered.

(More News on p. 260)



Hydraulic press. *Heavy steel plates are formed into construction product units in a matter of seconds on these 1000-ton hydraulic press brakes. Each brake is 22 ft long and can be used separately or operated in tandem as one 44-ft unit. Stroke is 18 in.* *(Armco Steel Corp.)*

TRUE enough, we're not merchandising experts . . . but we often solve a product design problem with zinc and aluminum die castings in a way that improves product appearance, lowers cost . . . gives a push to product sales!

Housewares manufacturers often bring their new devices to ADVANCE where competent die casting engineers and toolmakers solve product design and production problems to the sales advantage of the product.

Your sales problem as well as your cost reduction program may also find agreeable solutions with ADVANCE die cast treatment. Why not write or phone us today?

AMERICAN DIE CASTING INSTITUTE • MEMBER • ADCI

These symbols are your assurance of highest quality zinc and aluminum alloys under ASTM standards.

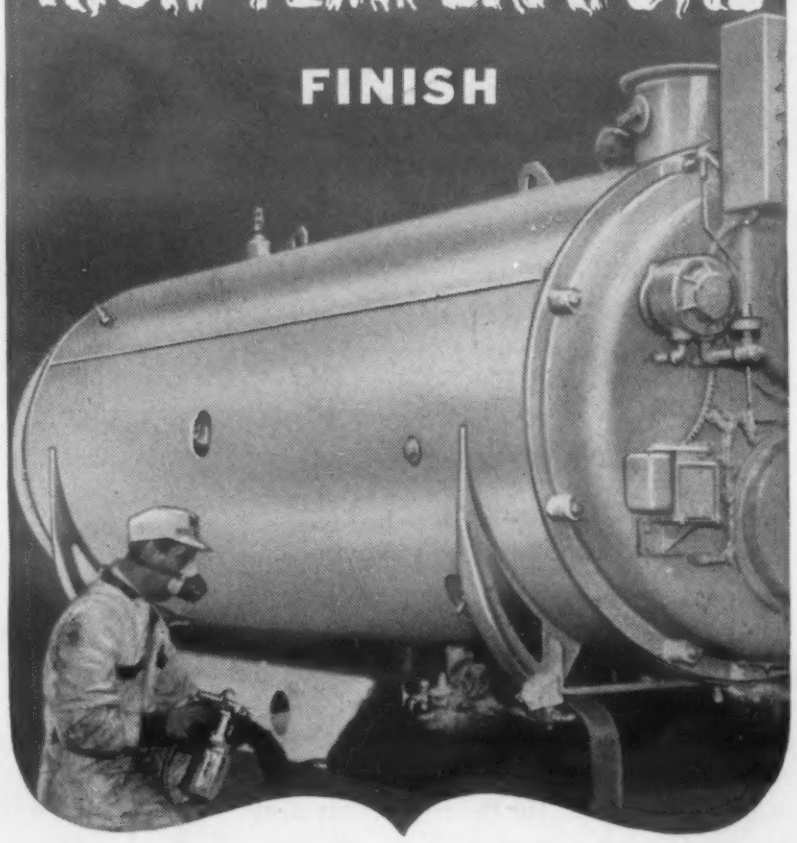
ADVANCE TOOL AND DIE CASTING CO.
3760 N. Holton St.
Milwaukee 12, Wis.

35 years of service to industry

For more information, turn to Reader Service Card, Circle No. 409

Sicon®

the original SILICONE HIGH TEMPERATURE FINISH



chosen for CLEAVER-BROOKS "CB" line of packaged boilers

SICON has reduced finishing costs for Cleaver-Brooks and provided a longer lasting finish that retains its color and gloss at temperatures in the range of 500° F., far above the hottest skin temperatures normally encountered.

Sparkling SICON Gray and SICON Maroon identify the "CB" line. One coat sprayed on is all that is required. It air-dries fast and maintains its attractive colors and protective qualities for the life of the unit.

For a silicone heat resistant finish that has stood the test of heat and time, write for the *complete* SICON story!

RETAINS COLOR AND GLOSS

FAST DRYING

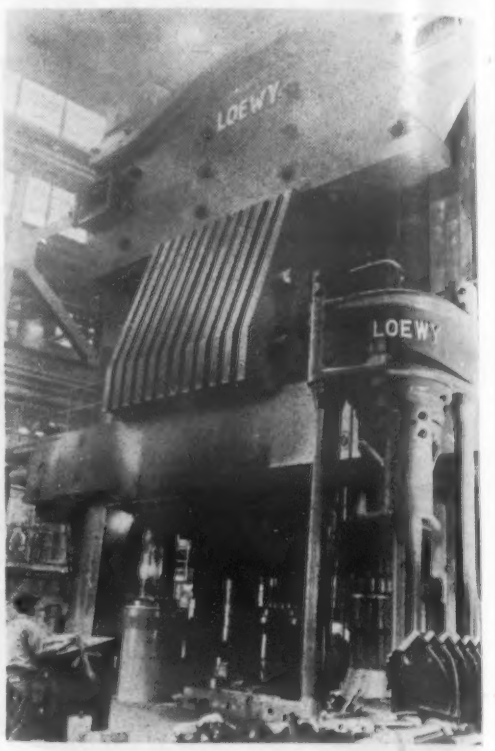
EASY TO APPLY

SICON® *is manufactured exclusively by*

MIDLAND Industrial Finishes Co.
EAST WATER ST., WAUKEGAN, ILLINOIS
ENAMELS SYNTHETICS LACQUERS VARNISHES

For more information, turn to Reader Service Card, Circle No. 393

MATERIALS ENGINEERING NEWS



Forging press. *Largest forging press in the world is operated by one man. Of its 10,750 ton total weight, 7500 tons are moving parts.*

Giant Press Goes Into Action

Exerting a pressure of 50,000 tons and equal in height to an 11-story building, the latest and largest addition to the Air Force heavy press program is now in operation at the Wyman-Gordon plant in North Grafton, Mass. The press, designed and built by Loewy-Hyropress, is the largest in the world.

Standing 50 ft above the operating floor and descending 60 ft below it, the giant press is suspended in a 100-ft pit surrounded by walls of concrete and steel up to 17 ft thick. Each of its six columns is made of three identical forged steel sections 110 ft long and 330 tons in weight. Total weight of the press is 10,750 tons.

(More News on p. 262)

Don't forget the
DESIGN ENGINEERING SHOW
Philadelphia Convention Hall
May 14-17.

"It Really Made Me THINK!"

"The other day when the Detrex man was in to see me, he dropped a couple pieces of information that really made me stop and think. The first thing he pointed out was that metalworking and surface preparation account for ¼ to ⅓ of all the operations in the average metalworking plant. That started the gears rolling. If this was true in our plant, here was a good spot to realize some important dollar savings.

"Well, after finding that 30% of our operations were in metal cleaning and surface preparation, I knew this was the spot to cut some costs . . . and no better way to start than by talking to a technician from Detrex. After all, they make a complete line of chemicals for metal cleaning and surface preparation —as well as the equipment too.

"To make a long story short, the Detrex technician surveyed our plant and came up with several cost-cutting suggestions that were pretty important to us. You know, I bet he could do the same thing for you in your plant. You don't even have to take the time to make the survey. I found out he will do it for you and it won't cost you a cent. Most likely you, too, will realize some important savings as a result of the survey. Talk to the Detrex technician about it the next time he calls, or write direct to their main office if you wish."

Service with a Saving!

DETREX CORP.

Dept. 602 • Box 501 • Detroit 32, Mich.

DEGREASERS • DEGREASING SOLVENTS • WASHERS
ALKALI & EMULSION CLEANERS • DRYCLEANING
EQUIPMENT • PHOSPHATE COATING PROCESSES

Phosphate Coating

Detrex zinc phosphate coatings provide a permanent, rust-resisting surface and at the same time bonds the paint finish to the metal. Paint peeling and flaking are retarded, corrosion from moisture is prevented. Phosphate coatings can be economically applied by either immersion or spray methods.

Emulsion Cleaners

Detrex emulsions clean metal and retard rust in one operation. Once metal parts have been cleaned with Detrex Emulsion Cleaners rust will not attack them. Because they will not attack any known metal or alloy, Detrex Emulsion Cleaners offer greater flexibility. Temperatures, concentrates and chemicals can be tailored to your specific cleaning needs.

Degreasing Solvent

Detrex Perm-A-Clor has superior stability and resists break-down into sludge or corrosive acid. Thus, Perm-A-Clor assures trouble-free, continuous production. Eliminates costly shutdowns for replacement of spoiled solvent, clean-out of sludge and neutralizing of cleaning equipment.

For more information, turn to Reader Service Card, Circle No. 336

MATERIALS ENGINEERING NEWS

Help Wanted

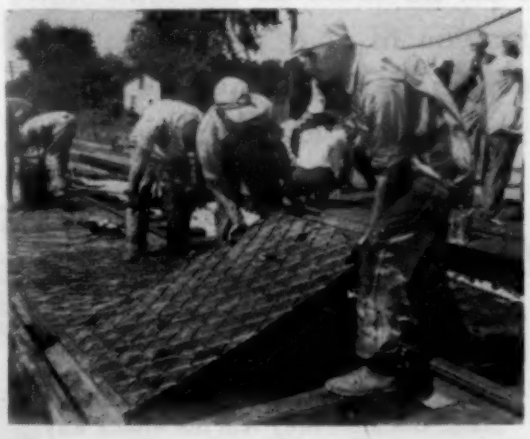
Anyone having a hobby, preoccupation, or annoyance with terminology and nomenclature problems in design work can help out on a project in the field of military engineering.

The Army Ordnance Corps has initiated the preparation of a comprehensive Ordnance Engineering Design Handbook to summarize fundamental principles and basic design data. The handbook is being written to provide needed information to army ordnance and arsenal personnel and to the engineering staffs of contractors having ordnance design responsibilities. It is planned that the handbook will consist of approximately 180 sections of about 100 pages each with completion of the first edition in about five years.

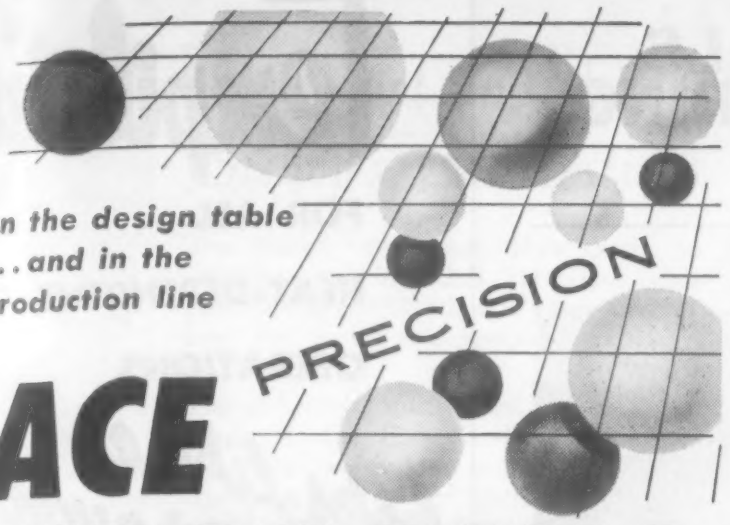
Collections of terminologies, glossaries, specialized dictionaries, or references to them will greatly aid the project. Contact: Allen Kent,, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

Rubber Crossing Smooths Ride

Motorists breezing along U. S. Highway 42 near West Salem, Ohio, will probably stop after crossing the Erie Railroad tracks,



***Rubber slabs** bonded to a supporting member of 7-gage steel are designed to replace traditional materials for railroad crossings.*



on the design table ...and in the production line

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ACE NYLON BALLS

KEEP THINGS MOVING SMOOTHLY IN HUNDREDS OF INDUSTRIAL APPLICATIONS!

Mass-Produced of DuPont Nylon FM No. 10001
To Close Tolerances of ±.001. Sizes ⅛" to ¾"

Ace Nylon Balls have brought new design flexibility and production economy to many of America's largest manufacturers. Uniform, precision-fabricated, light-weight Ace Nylon Balls are tough at low temperatures, stable at high temperatures, and resistant to chemicals and abrasion. Ace Nylon Balls may add greater efficiency and economy to your products, too.

Write for samples, bulletin, price list today

WHY NOT LET OUR ENGINEERS ADVISE YOU?

Complete facilities for fabricating plastic parts for all industries. Estimates submitted promptly on receipt of blueprints or specifications.

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Precision Plastic Fabricators and Extruders

ACE HIGH QUALITY

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WECKESSER
CABLE CLIPS

of all nylon ....

for high heat or other severe conditions

of ethyl cellulose ...

for maximum economy in average conditions

Light weight, strong, chemically resistant. No short circuits, no grounds, no corrosion, no rust. Only one fastener needed Sizes to 1¼ inches. Write for free samples and price sheet.

Exhibiting at the I.R.E. Show—Booth 863, Kingsbridge Armory

WECKESSER COMPANY
5255 Avondale Ave. Chicago 30, Illinois

For more information, turn to Reader Service Card, Circle No. 517

It's Hot-Dip Galvanized

Corrosion is costing the United States over five billion dollars a year, according to figures recently released. Companies today are taking a hard look at rust prevention costs. They are finding that Hot-Dip Galvanizing is the best solution to their problems. They know that items like chain-link fence, roofing, gutters, window sash, and many others will last longer if Hot-Dip Galvanized after fabrication. Over a period of years maintenance costs are kept to a minimum.

When you specify rust protection for your new buildings, specify Hot-Dip Galvanizing, the best rust protection you can buy. For the best in Galvanizing, have your products sent to a member of the AMERICAN HOT DIP GALVANIZERS ASSOCIATION—he has the know-how to give you a top quality job.

Send today for our new booklet "Stop Rust." It gives you the full story on the process, plus a comprehensive coating comparison chart. "Must It Rust" 16 mm film available for showing.

AMERICAN HOT-DIP GALVANIZERS ASSOCIATION

For more information, turn to Reader Service Card, Circle No. 459

MATERIALS ENGINEERING NEWS

Finished railroad crossing *presents a smooth, cushioned surface. Diamond pattern in the surface of rubber pads increases skid resistance.*

back up, and take another look.

What they see will be the first rubber highway railroad crossing, recently installed by the Erie Railroad. The new vehicular roadway consists of slabs of rubber with embedded seven-gage steel supporting members. Slabs are bolted through the railroad tie shims to regular roadbed ties. Provided with tapered flanges, the rubber slabs are designed to make a watertight seal with the rails.

Route 42 at this point is one of the most heavily traveled in the U. S. with the crossing battered around the clock by a constant stream of cars, trucks, and trains. The new rubber crossing is resilient to vibration from trains and motor vehicles and won't "float" or break up under the pounding.

In tests last year, Goodyear Tire and Rubber Co. laid an experimental crossing on the Erie line in Akron. After a winter and summer of use, the rubber slabs showed no apparent wear or deterioration. Based upon this experience, Erie Railroad officials expect the rubber crossing to reduce maintenance costs drastically.

Public relations-wise, the rubber roadway provides a smooth, cushioned ride for the motorist and should eliminate the special irritation usually reserved for railroad crossings by car owners.

(More News on p. 266)

MATERIALS ENGINEERING NEWS

Record size sheet. *This 500-lb sheet of rigid polyvinyl chloride has a 2-in. gage and measures 48 x 96 in. It is claimed to be largest ever produced.* *(Seiberling Rubber Co.)*

Arc Resistance Improved in Phenolics

Inserting small, non-conducting particles of an inert material into phenolic molding compound increases the resistance of molded electrical insulation as much as 1000%.

In a study made by Westinghouse Electric Corp., the nature of phenolic insulating materials was shown to be susceptible to arcing because of their chemical structure. The molecules contain chains of carbon atoms which tend to unlink under heat or strong electrical discharge, forming simpler chemical substances which conduct electricity.

By introducing submicroscopic particles—only 20 millionths of an inch in diameter—into the phenolic molding compound, the continuous path normally present for electric arc travel is effectively broken up. This method of preparing phenolic-type insulation does not sacrifice the other desirable properties of the material.

LETTERS TO THE EDITOR

Continued from p. 14

lower picture shows pre-cut strips of Quinorgo (a companion material to Quinterra) being inserted into an edge-wound field coil. However, the caption incorrectly says the mica is being used.

Finally, under the sub-head, "Asbestos base papers", we would like to comment on the statement, "Chrysotile asbestos, being easily fibrillated was the first to yield a 100% inorganic paper when 20% bentonite was added to the stock". Some bentonite was used when Quinterra was initially offered but the base paper now is made entirely of asbestos. No binders or fillers are used in its formation on the special equipment developed by Johns-Manville.

W. G. HOFFER
Manager, Electrical Insulations
Industrial Insulations Division
Johns-Manville Sales Corp.
New York, N. Y.

We appreciate the comments clarifying several points in Mr. Callinan's article. The incorrect caption, however, was entirely our error and not the author's.

Good finish

To the Editor:

We found your article, "Lacquer or Enamel", most enlightening and worthwhile. We are involved in writing a manual on design information for finishing procedures. We can use several items in your article to advantage in the organic finishing section.

L. J. ERCKMAN
Senior Standards Engineer
Link Aviation, Inc.
Binghamton, N.Y.

First editions

To the Editor:

I have the following volumes, bound in red buckram, and in very good condition, of Metals and Alloys:

Vol. 1—July 1929 to Dec. 1930
Vol. 2—Jan. 1931 to Dec. 1931
Vol. 3—Jan. 1932 to Dec. 1932
Vol. 4—Jan. 1933 to Dec. 1933
Vol. 5—Jan. 1934 to Dec. 1934
Vol. 6 Jan. 1935 to Dec. 1935
Vol. 7—Jan. 1936 to Dec. 1936

I shall appreciate being advised if you know of any demand for such volumes.

PETER R. KOSTING
Ordnance Corps
Watertown Arsenal
Watertown Mass.

In our opinion the volumes are, of course, priceless. Anyone care to make an offer?

Wrought aluminum alloys

To the Editor:

This letter will serve as our order for 1500 copies of the 16-page manual entitled *Wrought Aluminum Alloys* which appeared in your January 1956 issue.

DONALD F. HAGGERTY
Revere Copper and Brass Inc.
New York, N. Y.

To the Editor:

Please send me 300 reprints of your Materials & Methods Manual 123 entitled *Wrought Aluminum Alloys.*

GENE ALFRED
Harvey Aluminum
Torrance, California